DECEMBER 1953

Journal

VOL. 45 • NO. 12

AMERICAN WATER WORKS ASSOCIATION

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ASA Cast-Iron Pipe Standards	Panel Discussion
Pipe Corrosion	Eliassen, Lamb
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Responsibility Accounting	McDaniel
1950 Operating Data Analysis	Seidel, Johnson, Dencker
Conference and Section Programs	1953 Meetings
Journal AWWA Subjects and Authors	1953 Indexes

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150th anniversary

Journal

AMERICAN WATER WORKS ASSOCIATION

December 1953

Vol. 45 • No. 12

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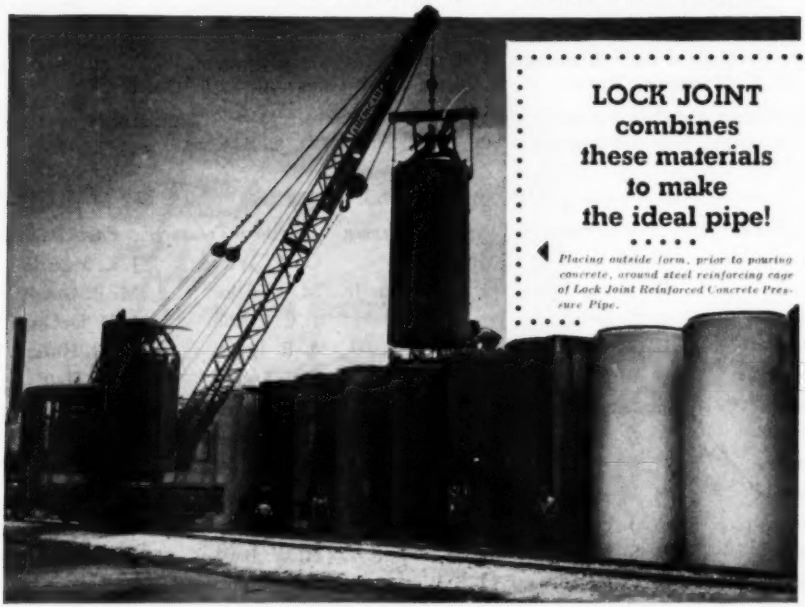

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AWWA SECTIONS

Jan. 19, 1954—New York Section Winter Luncheon Meeting, at Commodore Hotel, New York. Secretary, Kimball Blanchard, Rm. 1922, 50 W. 50 St., New York 20, N.Y.

Feb. 10–12—Indiana Section at Lincoln Hotel, Indianapolis. Secretary, G. G. Fassnacht, State Dept. of Health, 1330 W. Michigan St., Indianapolis 7, Ind.

Feb. 16—New Jersey Section Winter Luncheon Meeting, at Essex House, Newark, N.J. Secretary, C. B. Tygert, Box 178, Newark 1, N.J.

Mar. 17–19—Illinois Section at LaSalle Hotel, Chicago. Secretary, Dewey W. Johnson, Research Engr., Cast Iron Pipe Research Assn., 122 S. Michigan Ave., Chicago 3, Ill.

Mar. 18—New England Section at Hotel Statler, Boston. Secretary, George G. Bogren, Partner, Weston & Sampson, 14 Beacon St., Boston 8, Mass.

Mar. 29–31—Southeastern Section at Poinsette Hotel, Greenville, S.C. Secretary, N. M. deJarnette, 245 State Office Bldg., Atlanta 3, Ga.

Apr. 7–9—Kansas Section at Broadview Hotel, Emporia. Secretary, Harry W. Badley, Repr., Neptune Meter Co., 119 W. Cloud, Salina, Kan.

Apr. 12–14—Canadian Section at Royal York Hotel, Toronto. Secretary, A. E. Berry, Director, Ontario Dept. of Health, Parliament Bldgs., Toronto 8, Ont.

Apr. 22–23—Nebraska Section at Cornhusker Hotel, Lincoln. Secretary, E. Bruce Meier, Asst. Prof. of Civil Engineering, Univ. of Nebraska, Lincoln, Neb.

AWWA ANNUAL CONFERENCE

Seattle, Wash. **May 23-28, 1954**

All reservations will be cleared through the AWWA office. The hotels have agreed to accept no reservations for the 1954 Conference except as they are requested on the standard form, through the AWWA.

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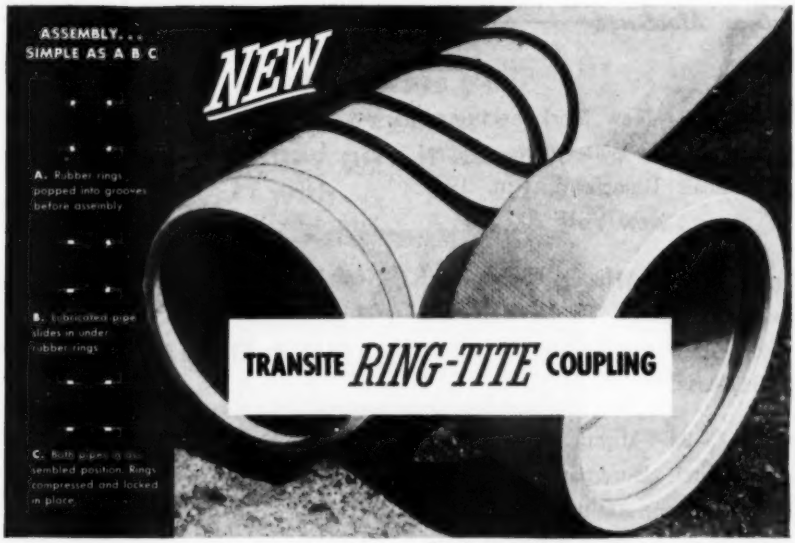
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Coming Meetings

(*Continued from page 8*)

Apr. 22–23—New York Section at Woodruff Hotel, Watertown. Secretary, Kimball Blanchard, Rm. 1922, 50 W. 50 St., New York 20, N.Y.

Apr. 22–24—Arizona Section in Tucson. Secretary, M. V. Ellis, Supervisor, Sewage Treatment Plant, Phoenix, Ariz.

Apr. 23–24—Montana Section at Baxter Hotel, Bozeman. Secretary, A. W. Clarkson, Acting Chief, Water Section, Div. of Environmental Sanitation, State Board of Health, Helena, Mont.

June 16–18—Pennsylvania Section at Americus Hotel, Allentown. Secretary, L. S. Morgan, Div. Engr., State Dept. of Health, Greensburg, Pa.

FALL SECTION MEETINGS

Sept. 9–10—New York, in Montauk, L.I.

Sept. 15–17—Michigan, in Muskegon

Sept. 22–24—Ohio, in Dayton

Sept. 26–28—Missouri, in Jefferson City

Sept. 28–30—Wisconsin, in Green Bay

Oct. 13–15—Iowa, in Cedar Rapids

Oct. 17–20—Southwest, in El Paso, Tex.

Oct. 24–27—Alabama-Mississippi, in Birmingham

Oct. 26–29—California, in Long Beach

Oct. 27–29—Chesapeake, in Baltimore

Nov. 3–5—Virginia, in Richmond

Nov. 4–6—New Jersey, in Atlantic City

Nov. 7–10—Florida, in St. Petersburg

OTHER ORGANIZATIONS

Mar. 15–19—National Assn. of Corrosion Engineers, in Kansas City, Mo.

May 4–6—American Public Power Assn., in Chicago

May 4–7—American Welding Society, in Buffalo, N.Y.

June 13–18—American Society for Testing Materials, in Chicago

Sept. 13–15—New England Water Works Assn., in Dixville Notch, N.H.

Oct. 11–14—Federation of Sewage & Industrial Wastes Assn., in Cincinnati.

Oct. 11–15 (tentative)—American Public Health Assn., in Buffalo

Oct. 17–20—American Society of Civil Engineers, in New York City

Oct. 19–22—Pennsylvania Water Works Assn., in Atlantic City, N.J.

Nov. 17–19—Water Works Management Short Course, at Univ. of Illinois, Allerton Park, Ill.

Nov. 28–Dec. 3—American Society of Mechanical Engineers, in New York.

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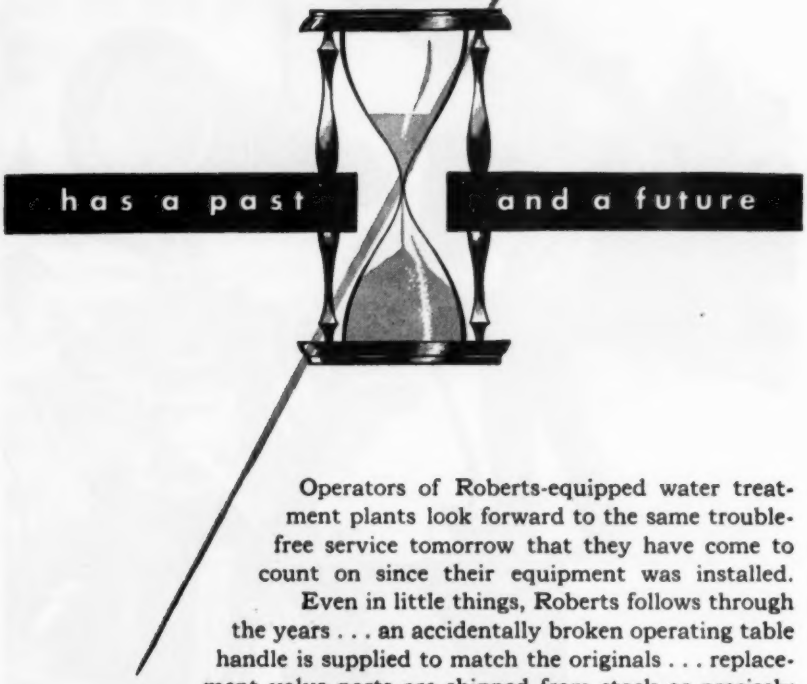

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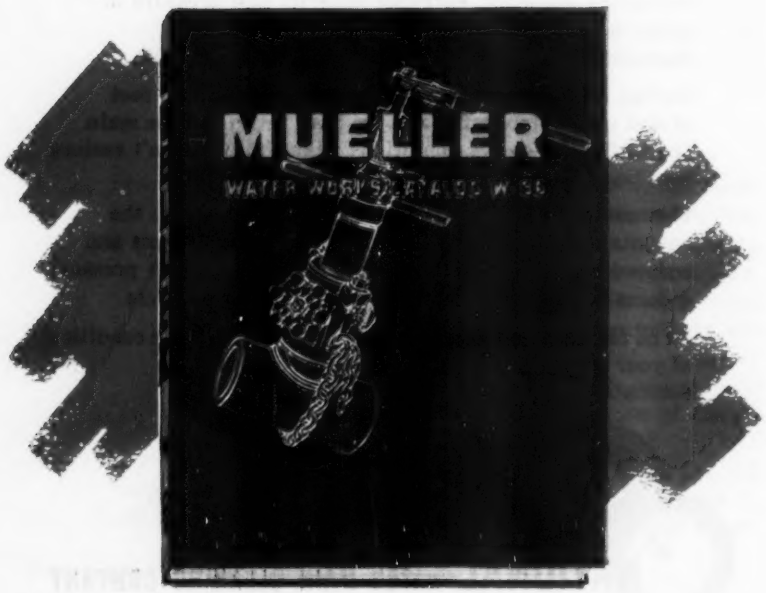

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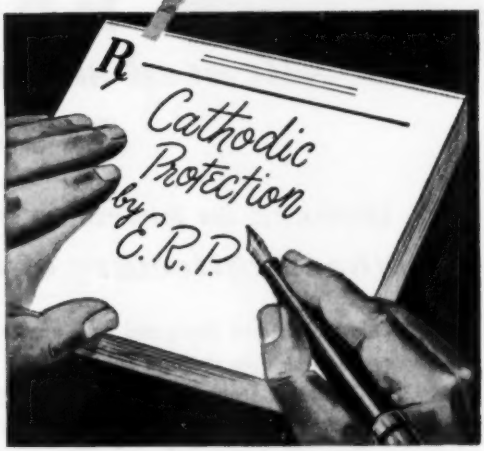

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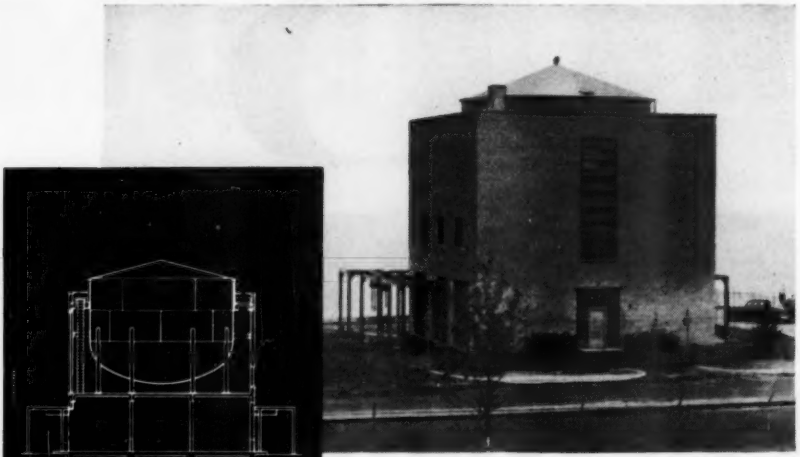

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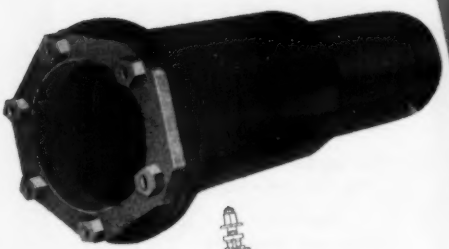

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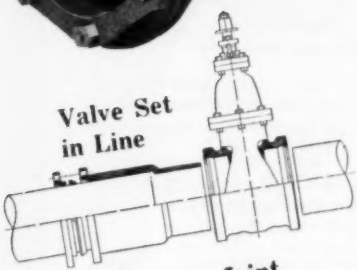

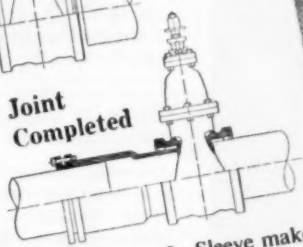

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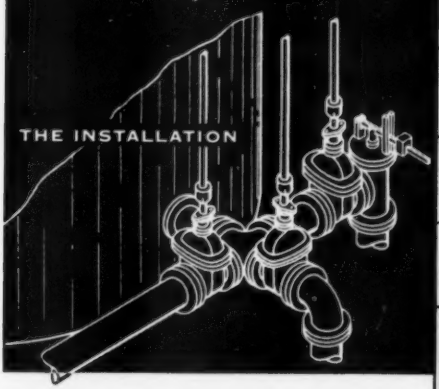

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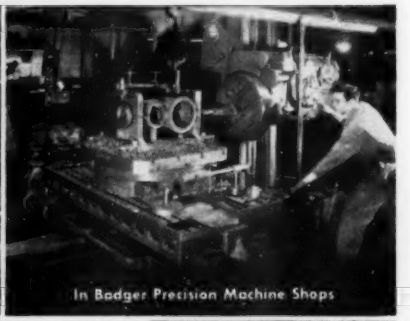
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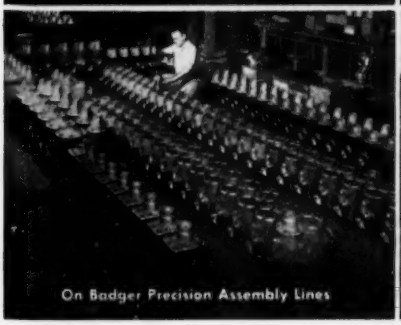
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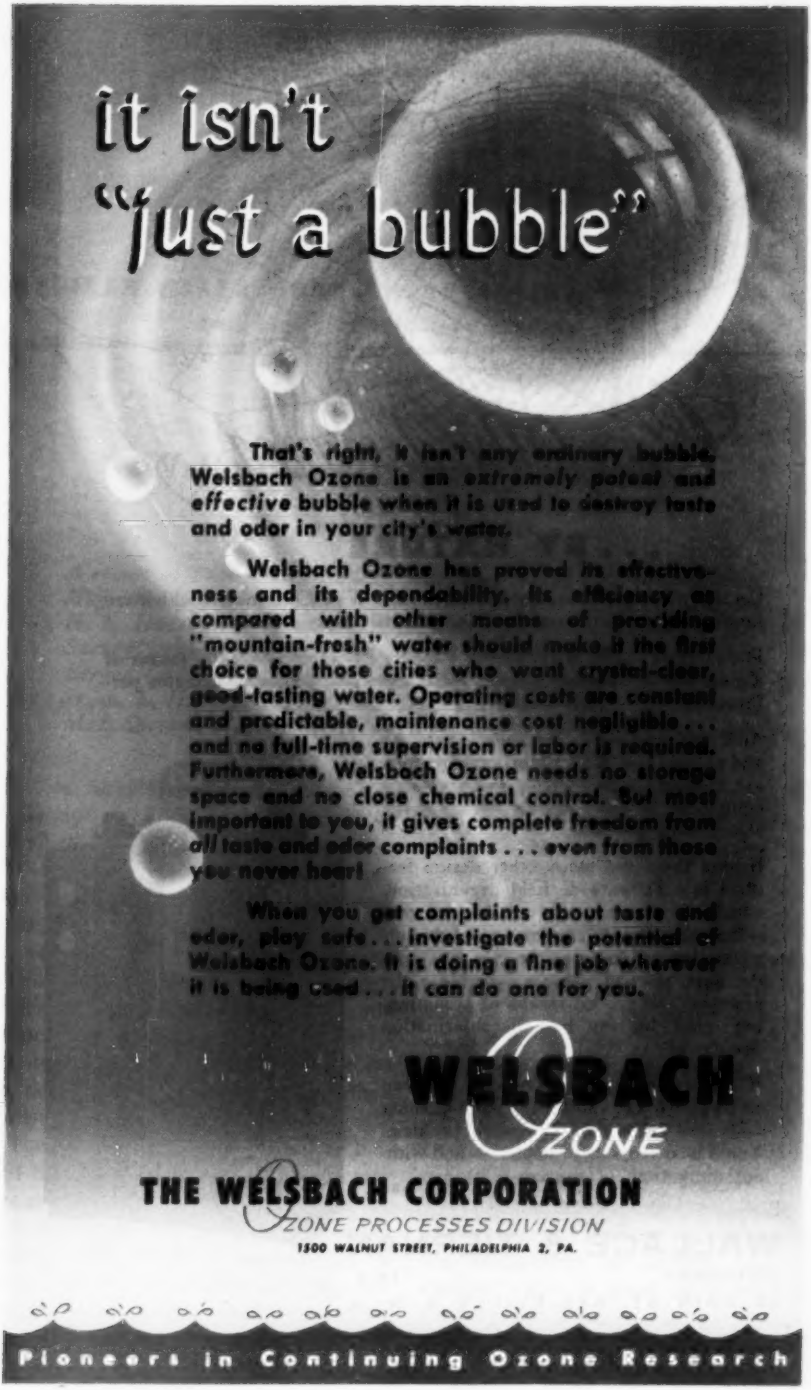
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Journal

AMERICAN WATER WORKS ASSOCIATION

VOL. 45 • DECEMBER 1953 • NO. 12

Water Conservation in Industry

Task Group Report

A report of Task Group A4.D1—Industrial Water Use, presented on May 14, 1953, at the Annual Conference, Grand Rapids, Mich., by H. E. Hudson Jr. (Chairman), Head, Eng. Subdiv., Illinois Water Survey, Urbana, Ill. Other members of the task group were: Stephen Bergen (Adviser), C. H. Capen, R. W. Davenport, R. W. Haywood Jr., L. L. Hedgepeth, H. R. Hooper, H. L. McMullin, S. T. Powell, M. J. Sassani, W. J. O'Connell, L. F. Warrick, and C. V. Youngquist.

IN its previous report, the Task Group on Industrial Water Use described four lines of activity for further work (*1*). Two of these have been followed out: [1] keeping track of studies in the field of industrial water requirements, and [2] gathering information on industrial conservation practices designed to reduce demands on potable-water resources. In addition to these activities, the task group has done some further work on definitions of terms.

The past decade has been characterized by a heightened interest in water resources. This fact is illustrated by the publication of a group of new texts dealing with water resources, by a sharp rise in the number of popular articles on availability of water, and by a greatly increased concern with the methods of water use in industry. The new publications in this field are extremely helpful in aiding industry to improve the job it is now doing in water utilization.

This growth of interest probably has both economic and social motivations. On the one hand, industry can save money by improved water use techniques; on the other, there is a growing awareness that industrial use in this country is nearly five times as great as domestic use and, in some areas, has exceeded the amount readily available for all purposes.

With the increasing employment of machinery, more efficient pumping, and the availability of electric power at cheaper rates in most sections of the country, the quantity requirements and types of water use will be tremendously

increased. Industry is recognizing that water can be as important as the raw material for its products and that the presence of a supply may become a critical factor in plant location and design. Undoubtedly, plant design in the future will give greater consideration to water use than it has given in the past. Both industry and the nation's economy will profit if every plant is designed for the maximum water conservation possible. This can be accomplished only if such conservation procedures are studied and made known.

In some locations, difficulties have been experienced with "heat pollution" of streams caused by successive reuse of water by industry. The temperature of the streams has been raised so high as to interfere with fish life and normal biological self-purification (*2*). It must be anticipated that recycling techniques, which tend to concentrate the mineral constituents present in the intake water into a volume of water only 2–5 per cent that of the original, may result in "concentrative pollution" of the water source. These problems will be aggravated by the disposal of wastes and water-conditioning plant brines.

Industrial water use and "concentrative pollution" are so closely linked with industrial-waste disposal that they come hand-in-hand into the purview of those concerned with the condition of America's streams. As Wolman has pointed out (*3*), this fact is likely to lead to the development of improved institutional arrangements for coordinating the needs of the general public with the activities of those who use a given waterway either as a water source or as a waste repository.

Recent Studies

Several useful studies involving water use have recently been published. A special feature article in *Power* (*4*) reviews the status of water resources and deals specifically with industrial problems. This article contains a good summary of the national situation and some specific, worth-while ideas for improvement in water use procedures in industrial plants.

A second publication is the three-volume series, *The Physical and Economic Foundation of Natural Resources*, prepared by the Interior and Insular Affairs Committee of the U.S. House of Representatives (*5*). The three parts of this series are entitled: "I. Photosynthesis—Basic Features of the Process"; "II. The Physical Basis of Water Supply and Its Principal Uses"; and "III. The Ground Water Regions of the United States [and] Their Storage Capacities." These three documents comprise a valuable, well-illustrated reference source for general information on the entire United States. The material on industrial water use in this congressional report is broad in scope and is largely based on a paper by Powell and Bacon (*6*) and on the Engineers Joint Council's 1950 report on national water policy (*7*).

The five-volume report of the President's Materials Policy Commission (*8*), known as the Paley Report, issued in June 1952, is also very valuable. It is especially good in depicting the role which water plays in American technology. Volume I ("Foundations for Growth and Security") contains a brief summary of the role of water in industrial development and estimates the anticipated withdrawals of water for 1975, as well as those for 1950. The figures indicate that a 90 per cent increase in total withdrawals of water is to be anticipated over this 25-year period. Industrial uses, estimated at 80 bil gal per day in 1950, are expected

to grow to 215 bil gal per day in 1975, an increase of 170 per cent. In 1975, the report estimates, industrial use will comprise 62 per cent of the national water withdrawal, whereas in 1950 it accounted for an estimated 43 per cent. Volume V ("Selected Reports to the Commission") contains a thorough and thoughtful paper by J. R. Barnes, who calls attention to the relationships of water problems to industrial location, pollution problems, and policies on irrigation and industrial use. He also contributes a useful discussion on developing new water supplies.

A review article that appeared in *Engineering-News Record* in 1952 summarized conservation techniques and the development of new sources (*9*). In the same year the American Society of Civil Engrs. published a symposium on "Consumptive Use of Water." This deals to a very limited extent with industrial aspects and is concentrated largely on rural and residential consumption.

The complexity of industrial water supply and the variations in quality requirements are indicated to some degree by Powers (*10*), who describes the use of five different water systems in one industrial establishment in Michigan. The quality, temperature, and quantity requirements are different for each. Some industrial processes can utilize raw water directly from the source, whereas others require clear, softened, deionized, or silica-free water.

Terminology

Terminology continues to give the task group some trouble. Not only is there disagreement on the meaning of the technical terms, but there is also a lack of consistency in their application. Still another obstacle to the comparison of research findings occurs in studies on industrial-water use in which no uniform classification of industry types has been accepted. For maximum utility, standard definitions and classification systems are an immediate and pressing necessity.

One of the technical terms concerning which there has been a confusing absence of agreement is "consumptive use." This term has an accepted meaning in the field of irrigation (*11*). The American Geophysical Union Committee on Absorption and Transpiration defined consumptive use as "the quantity of water per annum used by either cropped or natural vegetation in transpiration or in the building of plant tissue, together with water evaporated from the adjacent soil, snow, or from intercepted precipitation. It is sometimes termed 'evapotranspiration'" (*12*).

A committee of the American Society of Civil Engrs. defined consumptive use as "the quantity of water transpired and evaporated from a cropped area" (*13*). Another publication (*14*) by that society states: "The terms 'evapotranspiration' and 'consumptive use' have received general acceptance; these terms denote the quantity of water transpired by plants during their growth or retained in the plant tissue, plus the moisture evaporated from the surface of the soil and the vegetation, expressed in feet or inches depth of water lost or used in a specified time."

If these definitions are accepted, they should be adapted for more general use. The American Geophysical Union definition could be generalized to cover both agriculture and industry, as follows:

CONSUMPTIVE USE, *noun:* water, used in connection with vegetative growth, food processing, or incidental to an in-

dustrial process, which is discharged to the atmosphere or incorporated in the products of the process.

Some examples may be of aid in interpreting the terms "consumptive" and "nonconsumptive" in industrial situations. Consumptive use would include: makeup water for cooling towers to replace evaporation losses; direct use of water in products manufactured; makeup water to replace steam losses; water consumed by humans; water for lawn sprinkling, gardening, and the like. Nonconsumptive use would include: sanitary use of water (toilets, showers, and washrooms); contaminated process water discharged to waste; hot water not recoverable in the system; boiler blowdown water; surface condenser cooling water; jet condenser cooling water; cooling-tower blowdown water; backwash and rinse water from filters and softening equipment; water for floor washing; contaminated process wastes.

Kramsky (*15*) measured consumptive use in industrial processing by making a comparison of the industrial water intake with the resulting sewage effluent, based on the assumption that industrial waters are disposed of either by consumptive use or by discharge as industrial wastes. In the West Coast Basin of Los Angeles County, Kramsky found that 70 per cent of the industrial water intake failed to appear as waste water and was therefore consumptively used. This is an extremely high value and represents extensive use of recirculating techniques.

Another, and even more perplexing, problem is how to label the entire quantity of water taken for use in a process. It has been called "pumpage," "water intake," "duty of water," "withdrawal of water," "water requirement," and so on. The two large American water users, industry and agriculture, have certain elements in common regarding water withdrawn from a source for use:

1. There is some consumptive use in each instance.
2. Some of the water returns to liquid water sources, either underground or surface. Industries deliberately convey the unconsumed water back to a source, while agriculture reluctantly accepts some overland and seepage losses.
3. Industry discharges water that contains wastes from the industrial process. If there is appreciable consumptive use, this discharged water, through recycling, will have accumulated concentrations of salts brought into the process by the water. This is called blowdown. In irrigation, there is sometimes a comparable discharge of water laden with salts brought in by the applied water.

"Use" is another term which appears to have ambiguous meanings, and alternative terms have been suggested. The best of these appears to be that used by the National Assn. of Manufacturers (*16*), which employed the word "intake" with reference to the quantity of water brought into an industrial establishment daily. This term has the advantage of being very explicit and unmistakable. The term "use" might be modified to read "rate of use," in order to indicate the recirculating rate within the plant. It is fairly common for an industrial establishment to circulate water at rates ten times the intake rate.

Because of existing agricultural terminology, it is not possible to arrive at a definition of intake that will be equally applicable to both agricultural and industrial water use. The following definition is suggested primarily for industrial water:

INTAKE, *noun:* the rate of entry of water into an establishment required to maintain production within the establishment. It includes water required for consumptive uses and for waste disposal.

The term "intake" is generally synonymous with the agricultural term "water requirement" as defined by Blaney (*11*).

A variety of methods have been utilized in classifying water use in various industries, and industrial terminology has not been uniform. An excellent government manual (*17*) on this subject is available and, if followed, will insure that data gathered by one investigator will be comparable with those gathered by others, so far as classification of industries is concerned.

Unit Water Requirements

A number of tabulations of unit water requirements for various industries have been formulated, but all of them face the difficulty that the quantities used in different plants within one industry vary widely, depending on the extent to which conservation techniques are practiced (*18*). For example, the Kaiser Steel Corp. Fontana plant uses 1,100 gal of water per ton of steel, while the national average in this field is 65,000 gal. Water use in the paper industry is also subject to extremely wide variation in quantity per unit product (*19*).

The unit use of water in industrial establishments of a given type may be very high in places where water of suitable quality is available in sufficient abundance to permit once-through use, and may be very low—as little as 1 per cent of the high value—in places where water is very expensive and scarce. Perhaps the most useful figures to compile along these lines would be tables of minimum use for each industry, assembled from establishments with maximum conservation. This procedure, however, would involve so much judgment as to render these figures questionable. Moreover, all establishments cannot be expected to approach these minimum values, because the factors of availability and economy will vary from plant to plant. A similar situation exists with regard to costs.

Conservation Methods

There are a number of classifications under which methods of industrial water use might be considered: [1] general types of conservation, [2] techniques involved in various uses within the plant, [3] devices and equipment employed, and [4] special problems resulting from employment of these devices and methods. Conservation of water in industry may seek to minimize the use of potable waters that may be needed for other purposes, or it may seek only to cut costs of water handling. There are five general methods for conserving water within a plant:

1. Control techniques—using less water by avoiding waste
2. Recycling—using water over again in the same process
3. Multiple or successive use—using water from one process for one or more additional processes in the same establishment
4. Substitution of source—using water from another establishment, or using nonpotable waters
5. Nonevaporative cooling techniques—using special methods to reduce the amount of water required for cooling.

These methods are illustrated by a few typical examples in this report.

Control Techniques

The most obvious method of conserving water in any industrial establish-

ment is the elimination of waste or excessive flows. The conservation program at the Boeing Aircraft Corp. plant in Wichita, Kan., saves $350 per month in water bills through methods of this sort, with the major saving resulting from thermostatically controlled valves on the cooling systems of machines like air compressors, degreasers, and heavy presses (*20*). Where the water formerly streamed through, thermostats now retain it until temperatures of 80°–120°F are reached, thus reducing the former requirement approximately 70 per cent. The substitution of 4-gal toilet flush tanks for the former 7-gal tanks has also produced substantial savings. Clock- or photocell-operated flushing devices likewise reduce waste.

The Solar Aircraft Co., Des Moines, Iowa, paid off a $7,500 installation cost in 2 years and now saves $7,200 per year in water bills by somewhat similar methods plus recycling. Solar has learned the obvious value of plumbing maintenance and leakage control (*21*).

It is clear that very substantial savings can be made by tailoring water flows more exactly to the needs of the process. Electrically controlled valves that shut off water flow when a machine ceases operating have been very helpful. The use of refrigerated drinking fountains to eliminate the propping open of fountain valves has become a standard conservation measure. When refrigerated fountains are not used, a loop system bringing cool water past the fountains frequently eliminates the need for running them continuously in order to keep the water cold. This may often be done by arranging to bring incoming water past the drinking fountains before it goes to process use.

Float valves, controlled flushing devices, pressure and flow regulators, and other automatic controls are invaluable in minimizing water consumption. Water savers like automatic shutoff nozzles on hoses and group washbasins are valuable aids in controlling waste (*22*). Regular inspection, metering of flows, and close checking of amounts used are essential to good conservation practice. Of course, the maintenance of simple, yet suitable, records must accompany the metering installation.

The previous report of this task group (*1*) called attention to the fact that process water in an industrial establishment is taken for granted; the supply is so arranged that it need be given no further thought. This situation has been further emphasized by another review (*23*), which calls attention to the industrial fetish for wide-open valves. Industry freely uses control devices for the materials being processed but tends to avoid their use where water is concerned, on the grounds that the industrial plant is not in the water business but is manufacturing some other product. Because industry now uses five times as much water as municipal water plants do, this attitude is hardly justified. Industry is in the water business in a big way.

Recycling

Recycling, or the rerouting of used water from a process back to the same process for further use, is a method whereby the aggregate demand for water intake may be reduced without a decrease in the total water in circulation. The Timken plant at Canton, Ohio, installed recycling systems for the melt shop and rolling mill, with a resultant reduction of two-thirds in the amount of water intake (*24*). For the melt shop system, a recycled cooling tower was installed, and a cooling pond

in which mill scale is allowed to settle was built for the rolling mill.

Both the Boeing and Solar plants mentioned earlier have provided for the inclusion of cooling devices and recycling in their systems, to gain further economy of water use. Ninety-seven per cent of the water used in Standard Oil's Baton Rouge, La., refinery is for cooling purposes (*25*); the rest is used for boiler makeup, drinking, showers, fire, air conditioning, and other purposes. This corporation frequently finds it cheaper to build a cooling tower than to lay more mains to bring water to its plants. A National Assn. of Manufacturers survey indicated that, in 1950, approximately 39 per cent of the industrial plants covered by the study employed reuse techniques (*16*).

Sometimes the recycled water is too valuable to discard. This is especially true of steam condensate. Industrial plants reclaim approximately 70–90 per cent of this water, and some steam power generation plants have reclaimed up to 95 per cent.

The principal devices used in recycling techniques are employed for taking care of excess heat and for controlling water quality.

Heat transfer techniques. Foremost among the heat control devices is the exchanger, which is used for transferring valuable heat from a place where it is not wanted to a place where it may be either discharged or used.* Exchangers that transfer useful heat from a process effluent to influent material are emphasized to some extent, although not as widely as they might be. A good example is the steam boiler continuous-blowdown heat exchanger, which transfers waste heat from blowdown to boiler feedwater. In addition, chemicals in boiler blowdown may be used to reduce corrosion and scaling in other process waters. One industrial plant produces all its hot water by reclaiming waste heat (*26*).

The energy available in process wastes is often low-grade heat, with a temperature not high enough to be of value. The problem then becomes one of dissipating this unwanted heat. The most common devices utilized in recycling techniques are cooling ponds, spray ponds, gravity (natural-draft) cooling towers, and forced- and induced-draft cooling towers. These are listed in Table 1, together with estimates of the water losses they may entail. All these devices have the primary function of discharging heat to the atmosphere so that the remaining water may be reintroduced to the process at a temperature low enough to be useful. It is possible by proper design of spray towers to attain a temperature as low as 5°F above the wet-bulb temperature, although higher values are more common. Published tables of wet-bulb temperatures are available (*29*).

The evaporative condenser makes use of a two-cycle system in which a process coolant is circulated through tubes within the condenser to dispose of heat from the process. A closed circulation system sprays water over the tubes within the condenser in the presence of a controlled air draft, and the cooling takes place through the evaporation of the water, usually at temperatures well above the wet-bulb tem-

* Heat conservation in industry sometimes seems more important than water conservation, as it has been estimated that approximately half of the heat intake in industry is discharged as waste heat. Inasmuch as this heat is usually produced by nonrenewable resources, its conservation may be more critical than that of water.

perature. The recycled coolant may be a refrigerant, if low-temperature processing is required, or another material, if higher-temperature processing may be tolerated. Such condensers evaporate approximately 2 gph of water per ton of refrigeration. In addition, 1 gph of makeup water is usually required to compensate for blowdown (*30*).

Quality aspects. Recycling techniques, in which water may be used over again many times and concentrated through evaporation, inevitably produce marked changes in the quality of the water. These changes may be due to concentration of mineral salts and other materials, caused by evaporation of the water in the heat-dissipating device. The elevated temperatures commonly used and the recycling of the water tend to accentuate biological activity and corrosion problems. Because of these factors, screening, clarification, disinfection, filtration, softening, distillation, ion-exchange and demineralization techniques may be employed both on the intake water for the reuse system and on the recycled water. Slime control with germicides is commonly utilized, and corrosion control is, of course, essential.

The treatment of industrial waters has been reviewed thoroughly by Nordell (*19*), who outlines the types of treatment used in 320 different kinds of industries. The purposes for which water was treated in these industries include: boiler water, 312 industries; cooling water, 92; process water, 133; and general, 237. These data indicate that there is room for additional work on the treatment of cooling water.

The treatment of industrial waters presents more complex problems than those encountered in municipal purification and requires a high degree of specialization. Treatment is, of course, essential to effective recycling, although the treatment may actually be very simple.

The recycling of process water requires reconditioning to prevent suspended solids from accumulating. Such techniques have probably been carried furthest in the paper industry, in which intake savings of 80 per cent are not uncommon (*2*). The "bottling up" of process water has been a valuable aid in recovering worth-while materials and in preventing stream pollution in the paper and corn products industries (*2, 31*).

TABLE 1

*Characteristics of Evaporative Cooling Devices**

Device	Windage Loss *per cent*	Evaporation *per cent*	Blowdown *per cent*	Total Loss *per cent*	Short Circuiting	Relative Area Required
Pond						
Cooling	0	1	1	2	no	1,000
Spray	2–5	1		3–6	no	50
Tower						
Natural draft	0.5–1	1	0–0.5	1.5–2.5	no	1
Forced draft	0 –0.2	1	0.8	1.8–2.0	yes	1
Induced draft	0 –0.2	1	0.8	0.8–1	no	1

* Water losses based on 10°F cooling and two cycles of concentration. Water loss data from Miller (*27*); relative-area data from Degler (*28*).

Many processes require water treated to very exacting standards, some even more severe than those for municipal systems (*32*). Completely demineralized water is necessary for rinsing television tubes, for example.

Powell has dealt with water quality requirements for industry, covering kinds of use, water temperature and biological requirements, and corrosion and scale aspects (*33*). The special needs of paper and textile manufacture, pharmaceutical and biological operations, and steam generating are presented, together with a discussion of the methods used to achieve the quality desired.

Some aspects of the complexities of industrial water use have been outlined by Buswell (*33*), who points out the biological problems involved in recycling and multiple-use techniques and the chemical problems arising from the presence of hard-to-remove materials, such as oil, chlorides, and color. He emphasizes that increasing reuse methods will place more exacting requirements on waste treatment plants to insure uniformity of operation.

It is significant that chemical treatment may be practiced for corrosion and scale control in order to prevent product spoilage by process water, reduce replacement of equipment, reduce maintenance (avoid leakage), and maintain efficient heat transfer (avoid excessive use).

Multiple Use

Successive employment of water from one use or process for one or more additional purposes in the same establishment—here referred to as "multiple use"—is another effective conservation technique, which has resulted in important water intake reductions in industry.

In many processes, rearrangement or redesign of equipment to use the countercurrent flow principle will bring about substantial reductions in demand. Where a number of process units operate in series, the water should be applied to the cleanest or coolest material first and then successively to the dirtier or warmer materials, before being discharged. This procedure does not injure the quality of product and permits marked reductions in water requirements to be obtained.

Recent studies carried out by the Western Research Lab. of the National Canners Assn. at canneries in the Northwest established the practicability of reducing water requirements by one-half through multiple-use techniques. This was accomplished by applying fresh water near the end of the canning operations and using this water several times in the preceding steps; or, in other words, by employing the counterflow principle of multiple-use. The reduction in the quantity of fresh water required was effected without any deterioration in the quality of the canned products.

After the requirements for water have been set up, methods for successive use may be weighed. Such a procedure cut the use of water in a New York brewery more than two-thirds (*22*). The Fontana steel plant employs water successively for a number of different processes until it is all used up. It is reported that, in this instance, there would be some economy in saving a little water for blowdown, but the available resources do not permit it (*18*). Sometimes water from one source may be made to serve all of the requirements of an industrial establishment through multiple use. In other plants, water from several sources may

be used to fit the several specific process requirements.

Drinking fountain drainage and pump-sealing and bearing-cooling water can be collected and used for other purposes (*23*). Used process water is satisfactory for toilet flushing.

Substitution of Source

Substitution may involve an industry's use of water discharged by other agencies or obtained from other sources. The first step in studying methods of conservation by substitution is to determine the quantity, quality, and temperature requirements of each of the different water-using processes within a given establishment. A recent ASTM publication is of aid in ascertaining these standards (*34*).

Recharge of ground water. Plants using ground water because of its uniform coolness may augment their supply by recharge through spreading grounds, as has been done in the Duhernal system (*35*). Another example of the use of recharge was the wintertime injection of cool, purified Ohio River water from the city system at Louisville, Ky., in the Rubbertown area during World War II. This served to augment the supply of cool water for summer use. The seasonal substitution of cool surface waters for ground water in processes requiring low temperatures has real advantages and should, in time, increase considerably. Obviously, if the water supply is cooler, smaller quantities of water will be required for cooling purposes. Problems in "heat pollution" arise from returning used ground water to the formation from which it came, as on Long Island, N.Y.

Used water from other agencies. The most spectacular example of this procedure is the use of treated sewage by the Sparrows Point Steel Works at Baltimore, Md. (*36*). One Ohio steel plant rolling mill, however, found its water utilization efficiency somewhat improved by the use of a supply free of organic material. It is evident that the problem of quality requires consideration in taking advantage of used water.

At Champaign, Ill., a soybean mill uses, for cooling purposes, water from wells installed for a railroad yard, and returns the warm water to the railroad for use in locomotive watering and quenching.

Veatch (*37*) reported eleven instances of industrial use of treated sewage in 1948.

Use of nonpotable water. Where the source of supply for an industry is insufficient or competing demands limit use, surface water may frequently be substituted for ground water, or sea water may be used. Sea water is very widely employed in steam power plants in the New York region, for condenser cooling. The Redondo station of the Southern California Edison Co. uses sea water for condenser purposes. In this installation, there were serious difficulties with condenser fouling by mussels, as well as a slime control problem. These troubles were overcome by the use of chlorination and the occasional operation of condensers at temperatures greater than 100°F for an hour (*38*).

The Bayway Refinery in New York harbor uses sea water on a once-through basis, finding this method cheaper than recycling fresh water (*25*). Similarly, a steam power plant on Staten Island uses tidewater. Special materials must, of course, be employed to resist corrosion, and treatment to control biological activity is required (*39, 40*).

Storm water can also be collected and used.

Nonevaporative Cooling Techniques

Methods other than those classified above are available to aid in the major industrial function of dissipation of heat. Among these are radiative cooling and heat capacity storage.

Radiative cooling. There has been relatively little discussion of the direct discharge of heat to the atmosphere through radiative methods, but these are coming into wider use in areas where water resources are very limited. For example, an industrial establishment in Texas employs fan type radiator coolers for 90 per cent of the cooling work in the plant, recycling water in a closed system. The cooling water is given cation-exchange treatment, and only 16 gpm of makeup water is required for the plant (*41*). This procedure is fairly common in providing cooling water for pipeline pump engines.

Heat capacity storage. Another substitutive technique for reducing water requirements is the storage of heat capacity. This is sometimes accomplished through the operation of evaporative recycling systems overnight in order to cool the water in the system to the lowest possible temperature. The maximum wet-bulb temperature frequently occurs in midday and is of short duration, so that provision of some heat capacity through storage of cool water may enable the plant to operate through brief critical periods. Similarly, establishments using refrigerative cooling methods can store up heat capacity by the production of ice during off-peak periods, the ice being melted in a subsequent peak period. Computation of peak loads depends on weather data, and these are not yet available in as comprehensive a form as are other water resources data (*29*). So far as is known, national data on wet-bulb temperatures are available for only two 5-year periods.

Conclusion

It must be recognized that the narrowing margin between the present water supply and the amount ultimately available is going to require more knowledge, better engineering, and increased consideration of complicating factors on the part of water users. If water works men are to help meet the problem caused by the decreasing gap between supply and demand, they will not only need greater skill and alertness but will also have to arrange for increasing cooperation with industry.

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Economics of Adequate Leak Surveys

By H. E. Beckwith

A paper presented on Sept. 22, 1953, at the Kentucky-Tennessee Section Meeting, Owensboro, Ky., by H. E. Beckwith, Dist. Mgr., The Pitometer Co., Pittsburgh, Pa.

THERE has been ingrained into the minds of the general public the idea that water is a gift from above and that it should therefore be free to all. Does it not fall from the skies? Who, then, can own it, let alone sell it? The answer, of course, is that no one owns it and no one sells it, but a charge is made for purifying and delivering it—and a very low charge, at that. A dredging contractor for whom the author once worked used to buy water occasionally for $1.25 per ton. That does not seem to be a high price for hauling a ton of any material a distance of several miles. Yet this charge represents more than $5.00 per 1,000 gal. At an average domestic rate of $0.30 per 1,000 gal, water is being manufactured from an impure, unsafe raw material into a finished product that is safe and, it is hoped, pleasant to the taste. In addition, the water is delivered to the customer in the quantity desired and at the time desired—all at a cost of less than 8 cents per ton. Compare that with the charge for trucking a ton of dirt to fill a hole in the backyard!

Even when a farmer sinks a well, he finds that the water he gets is not "free." It costs perhaps $3.00–$7.00 a foot to put down a farm well, not to mention pumps and pressure tanks. If a well system is installed for as little as $500, the power, interest, and depreciation charges amount to approximately $50 per year. Certainly, the owner gets his water for nothing, but he has to pay for its delivery, even from his own well.

Perhaps one of the best things the AWWA has been doing recently is to impress the operators of water works properties with the fact that they are selling not water but service. Once the customers fully realize that fact, a large part of the utilities' troubles will be over.

When a community pools its resources and delegates the procurement and delivery of safe water to a central agency, the interest and depreciation costs apply in exactly the same way as they do on a private well. So do the power charges, as well as the costs of chemicals to purify the water and the charges for labor and materials to keep the plant operating. It is truly remarkable that all this is possible at a cost of only a few cents per ton.

Importance of Leakage

Perhaps the utilities have done too good a job in supplying water cheaply. Because costs are low, an attitude of tolerance toward inefficiency is likely to develop. If a little water is lost between the place of production and the point of delivery, it does not seem

to matter, because water does not cost much. Nevertheless, although the cost per thousand gallons delivered may be measured in pennies, the aggregate costs for the system as a whole may be rather sizable. If a tank truck were to load 5,000 gal of gasoline at the refinery and consistently reach its destination with only 4,000 gal remaining in the tank, something would be done about it immediately, but many water plants accept as normal a loss of 20 per cent or more of the total pumpage.

No such loss should be regarded complacently. Considering the time, energy, and money devoted to the production of pure, potable water, it is worth conserving. Waste of any kind is criminal, a statement that, now more than ever, is particularly true of water. As the postwar demand for water has reached new highs, it is becoming necessary to go farther and farther afield to obtain urgently needed supplies. The farther one has to go, the more the water costs. That portion of a supply which must be transported 20 miles costs much more than the water which has to be carried only 5 miles. Moreover, the situation is going to get worse. New demands are developing: air conditioning and increased bathroom facilities are raising the per capita use of water year by year. Population growth and urban development are straining available resources. All in all, some of the best estimates, made by the most experienced engineers only 10 or 15 years ago, have proved to be inadequate. As population encroaches upon and contaminates present sources of supply, or creates demands that are beyond the ability of present sources to meet, water will have to be carried over greater distances. As an inevitable corollary, the price of water will increase.

It makes no difference whether the utility has a gravity supply that requires little or no purification except for the addition of chlorine or whether it has a polluted surface supply to treat. The water is going to cost more in the future. The typical gravity mountain supply requires large dams and long transmission mains. The expenses are chiefly fixed and consist of interest and depreciation charges on the large amount of capital outlay required. When a stream or river is the source of supply, the plant is usually situated closer to town. The investment in pumps and filtration equipment is often very high, and, in addition, large amounts of chemicals and power are required. If the stream flow drops to such an extent that it endangers the continuity of supply, expensive dams may have to be constructed. Ground water supplies are being threatened or exhausted by overpumping, and new sources are being sought by an increasing number of water systems dependent on wells. These conditions add to the cost of the finished water.

The cheapest way to get water to meet increased demands is to save the water being produced, by increasing the "metered ratio"—that is, the ratio between the total meter registration and the output from the plant. The cost of saving this water is usually only a fraction of the cost of getting additional supplies.

Gravity Supplies

In the gravity type of plant, there may seem to be little point in conserving water. It flows by gravity, and all that is necessary to make it safe is to

add a little chlorine. Appearances are deceptive, however. Approximately 20 years ago, the author made an extensive study of the effect of waste upon stored supplies in two representative cities—Cumberland, Md., and Ashland, Pa. These studies are old, but nothing similar has been done since, and it is worth while to quote the results. Ashland, Pa., ran out of water at Christmas time, in 1931. The borough had an average use of 0.85 mgd and a stored gravity supply of 110 mil gal. The following spring a water waste survey was made, and the consumption was cut approximately 40 per cent, to 0.51 mgd. As a result of this saving, the borough was able to endure a more severe drought in 1932 without any threat to its supply. It was not even necessary to place restrictions on the use of water. Computations showed that this 40 per cent reduction in use provided as many additional days' supply as would have been assured by increasing the amount of stored water 100 per cent, or from 110 to 220 mil gal. It also took a large part of the load off the transmission main and increased pressures throughout the system, so that service was much improved on the hilltop. This improvement was secured at a cost of only approximately 1 per cent of the amount of capital outlay that would have been required to increase the size of the dam to give the same results. Other surveys have since been made at Ashland, but, when their cost is prorated over the years, it amounts to only a few hundred dollars annually, and the original dam is still adequate 21 years after the first survey.

Such a showing was possible because of the terrific effect that waste exerts upon stored supplies. In Ashland, before the leaks were repaired, the water level in the reservoir began to go down as soon as the stream flow, adjusted for reservoir losses, dropped below 0.85 mgd. After the waste had been stopped, however, the reservoir level did not drop until the stream flow fell below 0.51 mgd. The decrease in stream flow from 0.85 to 0.51 mgd might take several weeks. Moreover, when the stream flow fell to 0.25 mgd, the rate of depletion was reduced from 0.6 to 0.26 mgd.

In Cumberland, the 22 per cent reduction in consumption effected by the repair of underground leaks resulted in an increase of 43 per cent in the number of days' supply available from storage.

It is very probable that there are many gravity systems where an increase or decrease of 10 per cent in the amount of daily use would affect the number of days' supply available by as much as 25 per cent. This is equally true for systems where water is pumped from impounded supplies. Those extra days can be bought most cheaply by the elimination of waste. The cost is often only a fraction of 1 per cent of the cost of additional construction to give the same results. After all, the adequacy of a stored supply is not measured by the number of gallons it contains, but by the number of days it will last.

Pumped Supplies

The savings to be made on a pumped and filtered supply are more evident. A 10 per cent decrease in daily pumpage resulting from the stoppage of leaks should be immediately reflected in a 10 per cent reduction in power

consumption and chemical use. Here, again, there are other, equally important savings. Many plants are now producing at near capacity, so that a saving of 1 mgd would be equivalent to increasing plant capacity by that amount. As it is customary to build plants with a margin of capacity over actual use, the saving in plant capacity would actually exceed 1 mgd. If the margin were 50 per cent, the capacity represented by the saving would be 1.5 mgd. Costs vary, but an average cost of $200,000 for filter and pump capacity to produce 1.5 mgd of water would not be too far off. In more than half of the cities where a leakage survey has not been made in recent years, a saving of at least 10 per cent should be expected. It often exceeds this amount, sometimes by a wide margin. Within these limits, it is possible to increase the effective capacity of the plant for pennies, as compared to dollars needed for the construction of new facilities. Nor are the production facilities the only ones to benefit. By taking part of the load off the distribution system and the elevated tanks or reservoirs, their useful life is also extended.

By way of illustration, assume that a water system has a plant capacity of 12 mgd, and that the consumption is 10 mgd. This plant has a margin of 20 per cent of capacity over use. If a leakage survey resulted in the location and repair of leaks amounting to 1 mgd, the plant would still have a capacity of 12 mgd, but the use would have been cut to 9 mgd, thus increasing the margin of capacity over use to 33 per cent.

The leak is an expensive luxury, one that few, if any, utilities can afford. There is probably not a single plant that could deliver water at its present rates if it had to duplicate its facilities at current prices. Plants must be made to suffice as long as possible, in order to avoid the necessity for greatly increasing rates. The easiest, cheapest, and most effective way to do this, within reasonable limits, is by a water waste survey, which will locate and eliminate all underground leaks in mains and services.

In recent years water utilities have become very proud of their pumping stations and filtration plants. They are things of beauty and efficiency. They glisten in their cleanliness. They are rightly a source of pride. It is about time, however, that water works men began to pay equal attention to the distribution systems. Only too often they are poorly maintained; the valves will not work; and there are far too many leaks. Just because the mains cannot be seen is no reason to ignore them until something drastic happens. They cost a great deal of money, and that investment merits proper maintenance. Too many distribution systems are as wasteful as the hypothetical gasoline truck previously mentioned. There is no reason why the distribution system should not receive the same attention the production department gets. Bringing the records up to date, putting the valves in operating condition, and stopping the leaks will pay dividends—usually big dividends. Leakage costs do not admit of close evaluation, but it is certain that they are much higher than most operators realize.

Conclusion

In 1952 the author, in discussing a paper on this subject, casually men-

tioned that the time might not be too far distant when rate schedules, instead of being drawn up to encourage the use of water, might be established to discourage unreasonable uses, as many plants are approaching the limit of available supplies. Quite a few operators agreed that this might be so, particularly those whose supplies came from wells threatened with depletion from a lowering of the water table.

Perhaps the nation is becoming conscious that water is not merely something that falls from the skies. It is a natural resource that is not always available in unlimited quantities. It is something to be used, but not abused. Otherwise, there may come a day when it will not be there.

Americans are a profligate people. They have destroyed their forests, silted up their rivers and streams, and treated their natural resources as if they existed without limit. The country is coming to a belated realization that all of this has not been good. Although the waste of water may not at first seem to be in the same category, sober reflection will show that it arises from the same attitude that led to the ravaging of forests and streams. And now it costs money, plenty of money, much more than most people suppose It is time to stop waste!

Correction

In the committee report, "Census of Fluoridation in the United States and Canada, 1952," which appeared in the August 1953 JOURNAL, the date of the installation of fluoridation in the Washington Suburban Sanitary Dist. was given as June 1952 (page 899, last column of table). The correct date is December 1951.

New ASA Standards for Cast-Iron Pipe

Panel Discussion

A panel discussion presented on May 12, 1953, at the Annual Conference, Grand Rapids, Mich. A list of the ASA specifications discussed will be found in the Appendix (page 1280).

Development of A21 Specifications—*Thomas H. Wiggin*

A paper presented by Thomas H. Wiggin, Chairman, ASA Sectional Committee A21—Specifications for Cast-Iron Pipe and Special Castings; Cons. Engr., New York.

THE work of American Standards Assn. Sectional Committee A21—Specifications for Cast-Iron Pipe and Special Castings was inaugurated at an informal meeting of engineers and cast-iron pipe producers in 1926. Time has somewhat dimmed the details of that meeting, but it was probably inspired by a distinguished member of AWWA, the late Frank A. Barbour, who had tried unsuccessfully for many years, as chairman of an AWWA committee, to revise the AWWA specifications of 1908 (*1*) by improving the pertinence of the tests for iron. The author and the late W. R. Conard, both with foundry experience, had tried to assist in this work but without success, owing to the conflicting results of test bars. Present at the 1926 meeting, besides Barbour, were: W. Cullen Morris, Chief Engr., Consolidated Edison Co.; C. L. Warwick, Secy., American Society for Testing Materials; W. W. Brush; Norman F. S. Russell, Pres., U.S. Pipe and Foundry Co.; several other prominent foundrymen; the author; and some others whom he does not now recall.

Tests

Some new tests for cast-iron pipe had been devised by Prof. A. N. Talbot of the University of Illinois, including the now well-known strip and ring tests. The author voiced a long-standing conviction that cast-iron pipe laid in the ground ought not to be designed for bursting pressures alone but for bursting pressures combined with the crushing pressure of the earth fill. Allan Hazen, the author, and probably many others had taken earth loads into account in the design of important cast-iron mains. There was a well-developed technique at Iowa State College for testing trench loads alone. This had for some years been used by engineers for sewers not under internal hydraulic pressure.

The author agreed to take the chairmanship of a sectional committee if funds were made available for tests of combined earth loads and water pressure. The producers did not hesitate but promptly offered to tax themselves 25 cents per ton of cast-iron pipe produced in the previous year.

Committee A21 was soon organized with a membership of approximately 35, divided in a sort of balance between consumers, producers, and "general-interest" members, all under the rules and with the approval of the American Standards Assn. A chairman, vice-chairman, secretary, and treasurer were elected and were made ex officio members of an elected balanced executive committee of eleven. Several technical committees and subcommittees were elected by the executive committee, which had been given authority over committee membership and editorial matters but not over the substance of the specifications. The latter was left in the hands of the full sectional committee and required action by letter ballot authorized by the sectional committee after discussion of the subject matter at a meeting which had this clearly on the agenda contained in the advance notice of the meeting.

The principal findings of Committee A21 on design of straight pipe, including the method of computing thicknesses, and the results of tests on which this method was based, were contained in a paper by Dean M. L. Enger of the University of Illinois, Prof. W. J. Schlick of Iowa State College, and the present author, delivered before the AWWA convention at New Orleans in 1938 (*2*). The committee's work since that time has been, to a considerable extent, the application of that method to spun pipe for water and gas, but, in addition, specifications for cement lining have been studied at length, and revised specifications have been produced, as well as specifications for short-body fittings and for a mechanical joint.*

It should not be forgotten that the producers and some others furnished additional funds for an initial study of corrosion, made at Massachusetts Institute of Technology, in which the several practical types of cast iron and a high-nickel iron, too hard for ordinary use, were tested for corrosion; the conclusion clearly reached was that there is no practical chemical composition of cast iron that is noncorrodible. It is possible to make high-nickel cast iron that is very resistant to corrosion. It is used to carry certain corrosive chemical solutions but cannot be cut, drilled, and tapped in the practicable way required for ordinary use.

The producers also financed separately extensive tests of short-body fittings. These tests resulted in the standard, ASA A21.10–1952.

With the initial funds, the committee had Cornell University make loss-of-head tests on tees, crosses, one-quarter bends, and one-eighth bends, 6 in. and 12 in. in diameter.

The effect of varying the radii of fillets at the junction of main and branch pipe in tees and crosses was tested, and, as one result, a 2½ radius was chosen for short-body fittings.

Pullout tests of lead joints and harnesses, under conditions as at dead ends, were made under the joint auspices of Committee A21 and the water department of Columbus, Ohio.

Cement-mortar lining specifications for cast-iron pipe and fittings were issued in 1939 as ASA A21.4–1939. These have been revised as ASA A21.4–1953, the principal change being the inclusion of bituminous cure aids, sprayed on the lining as soon as it is in the least firm. Their purpose is to prevent loss of moisture and rapid loss of lime, which could result in caustic water.

* A list of A21 specifications appears on page 1280 of this issue.

Not the least effect of the committee's work, the author believes, was the stimulation of testing and a general technical laboratory approach at the pipe foundries to the production of cast-iron pipe and fittings. This trend has been growing steadily and has contributed to increasingly better and more uniform products. Among important provisions in assuring proper foundry preparation is one requiring full-length bursting and ring tests when a new order is to be put into production for sizes not recently so tested. These are the basic tests that assure proper strength.

Pipe Thickness

The pipe thickness schedules for ordinary pressures and depths of cover, resulting from the committee's work, do not differ greatly from those in common use—namely, the 1908 AWWA specifications for pit-cast water pipe and Federal Specifications WW–P–421 for centrifugally cast water pipe. This fact is partly due to the arbitrary limitations on minimum thickness, based on judgment and experience with breakage in handling. The extent of the changes —that is, the increases in thickness over computed thickness due to judgment— is clearly shown in the tables given in the manual, A21.1–1939.

Tables 1 and 2 of the present discussion give some comparisons of the Committee A21 thicknesses with the 1908 AWWA specifications for pit-cast pipe and with Federal Specifications WW–P–421 for centrifugally cast pipe. The Committee A21 thicknesses in these ta-

TABLE 1

*Comparisons of 1908 AWWA and Committeee A21 Specifications for Thicknesses of Cast-Iron Pit-cast Pipe**

Diam. *in.*	AWWA 1908 Class *A* (100-ft Head)	Committee A21 Class 50 (115-ft Head) 5-ft Cover		AWWA 1908 Class *B* (200-ft Head)	Committee A21 Class 100 (231-ft Head) 5-ft Cover	
		A†	*B*‡		*A*†	*B*‡
	Thickness—*in.*					
4	0.42	0.40	0.40	0.45	0.40	0.40
6	0.44	0.43	0.43	0.48	0.43	0.43
8	0.46	0.46	0.46	0.51	0.46	0.46
10	0.50	0.50	0.50	0.57	0.50	0.50
12	0.54	0.54	0.54	0.62	0.54	0.54
14	0.57	0.58	0.54	0.66	0.63	0.58
16	0.60	0.63	0.58	0.70	0.68	0.63
18	0.64	0.68	0.63	0.75	0.73	0.68
20	0.67	0.71	0.66	0.80	0.77	0.71
24	0.76	0.80	0.74	0.89	0.86	0.80
30	0.88	0.94	0.87	1.03	1.02	0.94
36	0.99	1.05	0.97	1.15	1.22	1.05
42	1.10	1.25	1.07	1.28	1.35	1.25
48	1.26	1.37	1.18	1.42	1.48	1.37

* It will be noted that the Committee A21 pressures are somewhat higher than those of AWWA.
† Laying conditions *A*: flat-bottom trench, no blocks, no special tamping.
‡ Laying conditions *B*: flat-bottom trench, no blocks, tamping beneath haunches and to above middle of pipe.

bles are for 5-ft cover, whereas the older specifications do not specify cover, which differs with climate. The principal tables in the Committee A21 specifications are for 5-ft cover and the *B* condition of loading (no blocks and tamping under haunches and to a little above the middle of the pipe). In the tables herewith, the thicknesses for *A* conditions of loading (no blocks and no tamping) also are given. A great deal of pipe has been laid on blocks without tamping, which gives a much more serious test of the strength of pipe. The *A* thicknesses for 50 psi (115-ft head) and 5-ft cover, except for small sizes, are generally somewhat greater than AWWA 1908 for 100-ft head. The *A* thicknesses for 100 psi (231-ft head) and 5-ft cover are somewhat less than AWWA 1908, except in sizes 36 in. and larger.

In the centrifugally cast pipe, the Committee A21 thicknesses for 150 psi and 5-ft cover are generally slightly less than AWWA 1908, and those for 250 psi are less than thicknesses in the WW–P–421 specifications, which, in turn, are less than the AWWA 1908 thicknesses.

For short-body fittings—the only fittings for which A21 has given designs (see A21.10–1952)—some thickening resulted from the insistence of the producers that they needed the rather liberal foundry tolerances that are provided in the AWWA specifications for fittings. This meant that the fittings must be strong enough to meet the pressure rating even if made thinner than standard by the amount of the tolerance. The producers said that, if no minus tolerances were permitted, the patterns would still have to be larger

TABLE 2

Comparisons of Federal and Committee A21 Specifications for Thicknesses of Centrifugally Cast Iron Pipe

Diam. *in.*	Class 150			Class 250		
	WW–P–421*	Committee A21 5-ft Cover		WW–P–421*	Committee A21 5-ft Cover	
		A†	*B*‡		*A*†	*B*‡
	Thickness—*in.*					
4	0.34	0.35	0.35	0.38	0.35	0.35
6	0.37	0.38	0.38	0.43	0.38	0.38
8	0.42	0.41	0.41	0.50	0.41	0.41
10	0.47	0.44	0.44	0.57	0.48	0.44
12	0.50	0.48	0.48	0.62	0.52	0.52
14	0.55	0.55	0.51	0.69	0.59	0.59
16	0.60	0.58	0.58	0.75	0.63	0.63
18	0.65	0.63	0.58	0.83	0.68	0.68
20	0.68	0.67	0.62	0.88	0.78	0.72
24	0.76	0.79	0.73	1.00	0.85	0.79

* Federal specifications dated July 21, 1931.
† Laying conditions *A*: flat-bottom trench, no blocks, no special tamping.
‡ Laying conditions *B*: flat-bottom trench, no blocks, tamping beneath haunches and to above middle of pipe.

by the amount of the same tolerances, to allow for error in casting.

Acknowledgments

The author would like to pay tribute to a goodly number of men, both producers and engineers, who have contributed to whatever improvements have resulted in foundry technique and in the specifications. Among producers should be mentioned the late W. D. Moore, formerly president of American Cast Iron Pipe Co., and J. T. MacKenzie and J. T. Vann of his staff and continuing; President (now Chairman of the Board) N. F. S. Russell and Vice-President D. B. Stokes (recently retired) of U.S. Pipe and Foundry, and H. W. Stuart of their staff; Douglas J. Peake, superintendent of R. D. Wood Co., and his engineer, L. A. Camerota. Among the water and gas engineer members, Leonard P. Wood, W. W. Brush, H. W. Griswold, A. L. Shaw, Reeves Newsom, and the late Frank A. Barbour, W. C. Hawley, and Frank H. Stephenson stand out in the author's memory. Nor should one forget the late Arthur V. Ruggles, who assisted the chairman for several years and contributed sound, practical knowledge of cast-iron pipe and the order of a systematic mind. The members from the gas interests have all been cooperative and helpful, beginning with the late W. Cullen Morris, former chief engineer of the Consolidated Edison Co. and an active member of the American Gas Assn., who lent his great influence in starting the committee; H. L. Peden, also of the Consolidated Edison Co.; and, in recent years, C. C. Jones, Supt., Eng. Div., Philadelphia Gas Works. The latter has been of outstanding help as chairman of the subcommittee on mechanical joints and in assembling the specifications for gas pipe.

Professor W. J. Schlick of Iowa State College, who made the combined earth and pressure tests and devised the method used by the committee in computing the thickness of the pipe barrel, and Dean M. L. Enger of the University of Illinois, who made many bursting and other tests and advised on many technical problems, should be especially remembered for their great contribution to the committee's work.

The AWWA executive staff has given continued support to the chairman and has aided in getting many of the specifications through the rather elaborate red tape of acceptance by the four sponsors and by the ASA. The author will say to those who have not worked with ASA sectional committees that their procedure is much stricter than that of any other association with which the author has had experience—and that includes a considerable number. Not only must ballots be counted and substantial unanimity be shown, but reasons for negative ballots or for not voting must also be explained to the ASA before clearance can be obtained.

References

1. Standard Specifications for Cast-Iron Pipe and Special Castings—AWWA 7C.1–1908. *Proc. AWWA*, p. 771 (1908).
2. Wiggin, T. H.; Enger, M. L.; & Schlick, W. J. A Proposed New Method for Determining Barrel Thicknesses of Cast-Iron Pipe. *Jour. AWWA*, **31**: 841 (May 1939).

Cast-Iron Pipe Tests—*J. Thompson Vann*

A paper presented by J. Thompson Vann, Asst. Works Mgr., American Cast Iron Pipe Co., Birmingham, Ala.

The ASA A21 series of pipe specifications rationalizes the problem of determining the correct metal thickness of cast-iron water pipe for any given condition of external loading and internal pressure. Different types of laying conditions are defined, and the effect of the particular laying condition, together with that of the depth of earth cover and the internal pressure, is used in the pipe thickness calculation. The thicknesses given in Specifications A21.2, A21.6, and A21.8 were calculated using two different minimum strengths of iron. The pit-cast pipe specification (A21.2) uses 11,000-psi full-length bursting tensile strength and 31,000-psi ring modulus of rupture; A21.6 and A21.8, the two specifications for centrifugally cast pipe, specify 18,000-psi bursting tensile strength and 40,000-psi ring modulus of rupture.

The load pressure equation, as developed by Committee A21, is stated in terms of external loads and internal pressures. The specifications require the pipe to meet specified tests that are measures of its strength against these external and internal loads. These tests are not new to the pipe manufacturers, some of them having been in regular use for many years; all of them

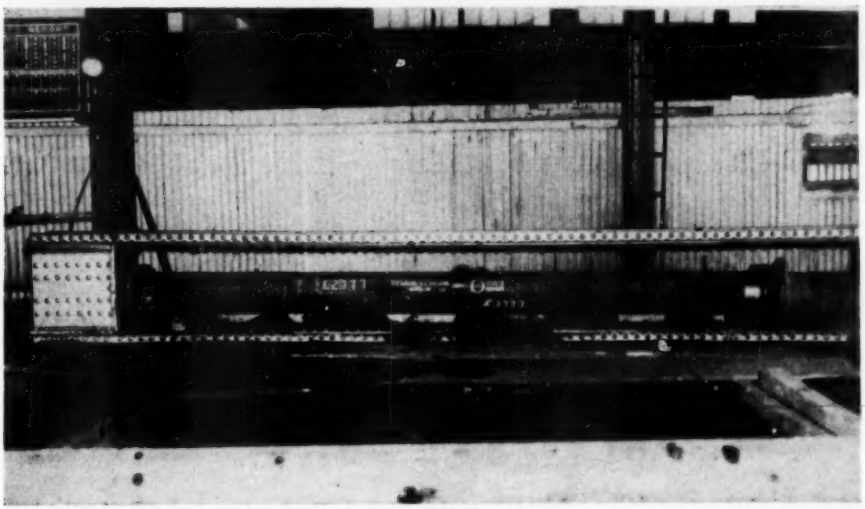

Fig. 1. Full-Length Bursting Test

The pipe ends are capped, and the assembly is blocked in a test frame that restrains the closures against end thrust but allows the pipe to remain free. The pipe is filled with water, and pressure is applied slowly until failure.

have been used for 20 years or more by at least some of the m ıufacturers.

The full-length bursting test (Fig. 1), which measures the pipe strength against internal pressure, is one of the fundamental tests in this field. It is an excellent gage of the quality of the pipe, because the entire length, less a short section for ring and strip tests, is subjected to the test pressure. The ends of the pipe are closed by caps, and the assembly is blocked in a test frame that restrains the closures against the end thrust but allows the pipe to remain free in the same manner as it would in the system. The pipe is filled with water, and pressure is applied slowly until failure. The pressure at bursting and the diameter and thickness of the pipe are substituted in the standard formula to obtain the bursting tensile strength. This figure must meet the minimum requirements of the specification.

The ring or three-edge bearing test (Fig. 2), also fundamental, measures the resistance of the pipe to crushing loads. Rings are cut from all pipe used for the bursting test and from such other pipe as is selected. The length of the ring varies from one-half the pipe diameter to a maximum of 12 in. The samples are broken in a testing machine, with the ring supported on two lower bearings and loaded through a single upper bearing. The breaking

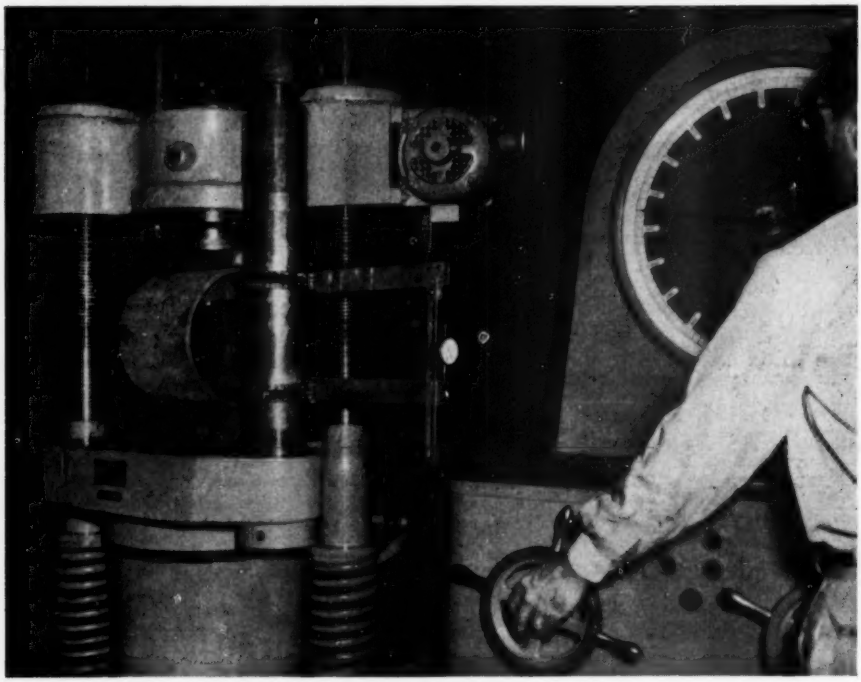

Fig. 2. Ring Test

In this three-edge bearing test, the breaking load and vertical deformation are observed.

load and the vertical deformation of the ring are observed, and the modulus of rupture and modulus of elasticity are calculated by the standard formulas. The modulus of rupture must meet the minimum requirements of the specifications.

The ring test does not, in itself, represent any field condition, but the breaking load per foot in three-edge bearings has been correlated with the various field conditions by Committee A21.

The Talbot strip test (Fig. 3) has been a standard cast-iron pipe test for many years. It is the acceptance test for centrifugally cast pipe in sizes 3–24 in. and is an alternate acceptance test for pit-cast pipe and large centrifugal pipe cast in sand-lined molds.

The centrifugally cast pipe specifications require that at least one strip be cut from pipe cast during each 3-hr period of the heat. The first sample must be from the first hour or, if casting is direct from the cupola, from the first ladle. Also, each size of pipe cast for 2 hr or longer and each mixture of iron used for 2 hr or longer must be fairly represented in the sampling for strips.

The test strip is ½ in. wide, with a depth equal to the full wall thickness of the pipe. It must be sufficiently long to test on supports 10 in. apart. The strip is tested as a beam, with the loads

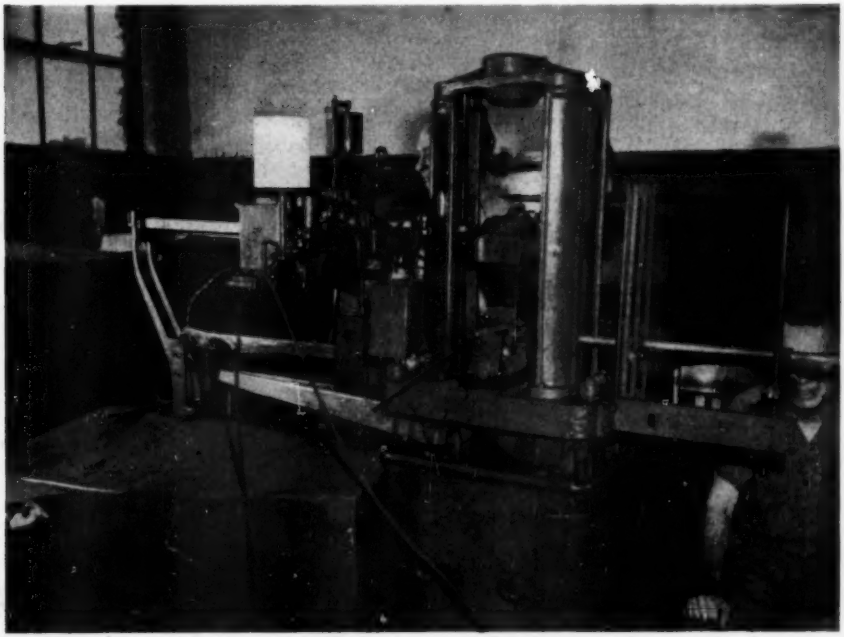

Fig. 3. Talbot Strip Test

The test strip is ½ in. wide, its depth is the full wall thickness of the pipe, and it is long enough to rest on supports 10 in. apart. Loads are applied perpendicularly to the machined faces, at two points 3½ in. from the supports. (Arrow points to test strip.)

applied perpendicularly to the machined faces at two points 3½ in. from the supports. The breaking load and deflection at the midpoint of the strip, together with the measured dimensions of the strip, are substituted in the standard formulas to obtain the modulus of rupture and modulus of elasticity. The strip modulus of rupture is specified as a minimum in the various specifications and the modulus of elasticity as a maximum.

A hardness test on the outside of each pipe is specified in A21.6 as a check on the annealing. A similar test is required on each Talbot strip. The maximum equivalent Rockwell hardness number is B–95.

The acceptance tests for pit-cast pipe and for 30-in. and larger pipe centrifugally cast in sand-lined molds are test bar tests (Fig. 4). The pit-cast bar is the 2 × 1-in. AWWA bar, which is broken as a beam on 24-in. supports with center loading. The bar for the A21.8 large pipe cast in sand-lined molds is the 2-in. ASTM round bar, which is also broken on 24-in. supports with center loading.

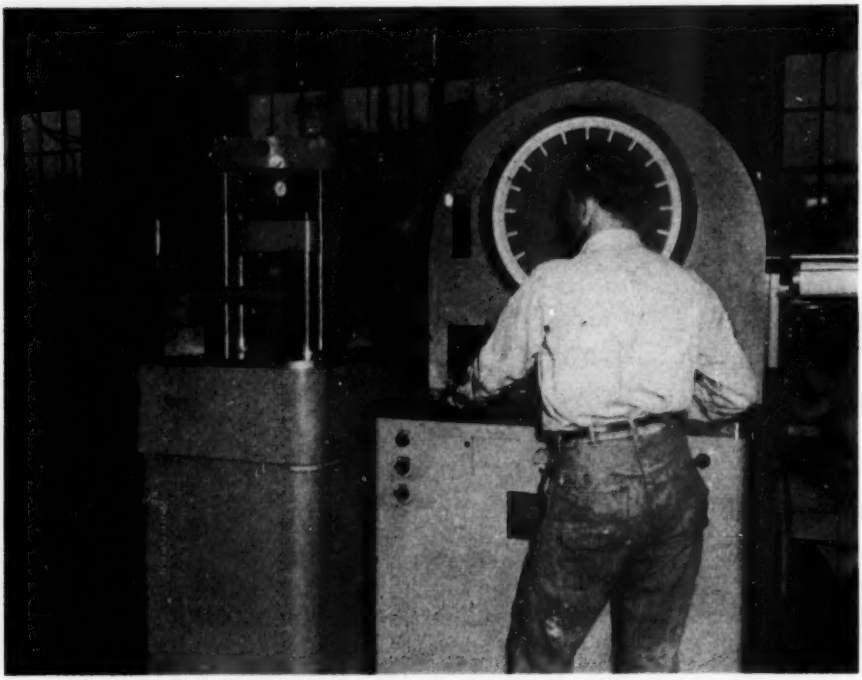

Fig. 4. Test Bar Test

Center loading is applied to the bar, which rests on supports 24 in. apart.

The specifications require a hydrostatic test on all of the pipe, with test pressures varying up to 500 psi, depending on the size and class of pipe.

Chemical analyses of the iron are required from the first hour and from at

least each 3-hr period during the heat. Phosphorus cannot exceed 0.90 per cent and sulfur 0.12 per cent. The pouring temperatures of the iron must be measured for each size of pipe at least once each hour.

All of these tests are required to be a part of the foundry record and must be retained for at least a year. This record is available for inspection at the foundry, and transcripts of the tests may be obtained.

Manufacturing Considerations—*H. W. Stuart*

A paper presented by H. W. Stuart, Director of Quality Control, U.S. Pipe & Foundry Co., Burlington, N.J.

Manufacturing considerations in the production of cast-iron pipe lined with cement in accordance with ASA Specification A21.4–1953 can be summarized in a few words. The latest revision of A21.4, which was first issued in 1939, is very significant for the manufacturer and assures the consumer of a product that is made from higher-quality materials and meets more exacting process and product requirements.

The ASA method of writing specifications provides a necessary balance among producer, consumer, and general interests. The recent revision of A21.4 is a good example of the contributions of all of these groups.

Pipe manufacturers are now obliged to meet the following new requirements: [1] ASTM Type II cement rather than Type I; [2] more definite grading of sand size; [3] a definite frequency of testing the sand and cement, as well as the finished lining; and [4] recording of these test results to assure interested consumers of adherence to the specifications. Many manufacturers have been approaching the requirements of this specification for the past several years. In other words, as is usual, the revised specification is not radically different from the good practice of the industry, and it should be satisfactory to all concerned.

A21.10

Production of short-body cast-iron fittings, 3–12 in., for 250-psi water pressure plus water hammer, in accordance with ASA Specification A21.10, differs very little from the production of fittings of this same size in accordance with AWWA C100 (1). The design of ASA short-body fittings lends itself well to mechanized production, and their short length and greater iron strength requirements give them a higher water pressure rating, which has already made the specification popular. In fact, owing to consumer demand, these fittings had been produced by some foundries prior to ASA approval of the specification. The manufacturer is required by A21.10 to make the castings from iron having a maximum of 0.90 per cent phosphorus and 0.12 per cent sulfur. The iron from which the fittings are made must meet minimum 2 × 1-in. test bar requirements of 2,300-lb breaking load and 0.30-in. deflection.

Generally speaking, it is not particularly difficult for the manufacturer to produce these fittings and have them on hand for ready shipment, as long as the consumer elects to use the standard bell ends. Unnecessary requests for ends other than bells reduce the overall economic advantage of these fittings

and very often cause needless delays in procurement. The standard all-bell fittings can be used for most conditions, and combinations of standard fittings that may be employed in place of special fittings are shown in the *Handbook of Cast Iron Pipe* (*2*).

A21.11

ASA Specification A21.11, covering a mechanical joint, is particularly significant for the manufacturer of cast-iron pipe and fittings. Mechanical joints of the general design described in the specification have been made by individual cast-iron pipe companies for approximately 25 years.

This particular mechanical joint was established as an industry standard in 1944, when it was realized by the members of the Cast Iron Pipe Research Assn. that it would be much more acceptable from the consumers' point of view if the manufacturers of similar joints would reconcile their minor design differences and produce an improved joint that could be used interchangeably. To accomplish this standardization, several manufacturers had to change considerable foundry and accessory equipment. The usual difficulties associated with closer tolerances were encountered, but it was possible to solve most of the problems within the plants, and general acceptance of the standard was very prompt.

The ASA standardization of this joint was, to the author's knowledge, the most rapid action ever taken by Sectional Committee A21, and much of the credit should go to the members of the AWWA Water Works Practice Committee, who were most cooperative.

The ASA specification covered in much greater detail the items previously standardized voluntarily by the producer interests. As manufacturers continue to use this specification, they increasingly realize how important it is to have this detailed guide in the hands of all concerned.

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2. *Handbook of Cast Iron Pipe.* Cast Iron Pipe Research Assn., Chicago (1952). p. 400.

Consulting Engineer's Viewpoint—*Louis R. Howson*

A paper presented by Louis R. Howson, Partner, Alvord, Burdick & Howson, Chicago.

The consulting engineer refers to accepted standard specifications, modified in such particulars as are necessary to define more clearly the requirements for a particular project, in order to avail himself of the composite experience of qualified men who have developed the specification he is using. The committees working on the ASA specifications for cast-iron pipe included representatives of both users and manufacturers, and committee personnel were selected from the membership of the participating societies for their broad experience with cast-iron pipe production and use. The finished results, therefore, represent the composite judgment of a large cross section of experience. As is usual in committee operations, particularly when the committee is a large one, much of the responsibility and work fell on the chairman. In this instance, the users of cast-iron pipe owe much to Thomas H. Wiggin.

In appraising specifications such as these, the consulting engineer has sev-

eral basic requirements which the specifications must meet. First, they must clearly define good materials. In this respect, the ASA specifications are believed to represent the best and latest thinking derived from a long background of experience.

A second requirement of the specifications is that their use should make it practicable to purchase materials under them without controversy regarding the interpretation of the specifications themselves. In that respect, these specifications have been carefully developed and edited. The specifications are both full and explicit, and as compact and condensed as is practicable.

A third requirement of specifications is that they should specify the results to be desired in the finished product but should allow the manufacturers reasonable latitude in production methods to meet those requirements and furnish a satisfactory product at least cost. This requirement of a good specification was met by having the committee include manufacturers' representatives fully acquainted with the details of production and the factors that influence production costs. Thus, the best finished product is available under these specifications at the lowest cost.

Fourth, a good specification must provide workable tests by which the engineer can measure how closely the materials furnished comply with the specifications under which the purchase was made. This requirement is believed to have been well covered in the present specifications by the Talbot test strips, hydrostatic tests, and so forth. Certified copies of the manufacturers' tests are available to the purchaser upon request.

Cast-iron pipe has a record of nearly 150 years of water works service in this country. During that period the quality of castings, the tolerances of foreign materials in the cast iron, the methods of casting, and the resulting uniformity of thickness, freedom from blowholes, and so forth, all have been greatly improved.

Consulting engineers, when recommending cast-iron pipe for water works service, have for several decades relied mostly on the 1908 AWWA specifications, supplemented in later years by the federal specifications for centrifugal pipe. It was only natural that, with the development of the art of casting and with an accumulated background of experience, some deficiencies in these specifications would arise. It is believed that the present A21 specifications, from the consulting engineer's standpoint, fully reflect the best thinking and experience in the cast-iron pipe industry at present. They should be widely used and, in conjunction with the manual (A21.1) and the AWWA specifications (C600) for pipe laying, which so well outline the essentials of ditch construction and installation of cast-iron pipe, will furnish a useful guide for years to come.

Linings

There is one deficiency in the specifications from the consulting engineer's point of view. This fault, for which Committee A21 is not to blame, has to do with linings. There is a complete specification (A21.4) covering the installation of cement-mortar linings on cast-iron pipe. Although an increasing amount of cast-iron pipe is being lined with cement mortar, bituminous coatings always have been and still are the predominant type employed for cast-iron water pipe. With many waters, such as those of the Great Lakes, the bituminous or tar-dipped coatings have demonstrated their ability to maintain the carrying capacity of cast-iron pipe

for long periods. Extensive pitometer surveys at Chicago, Milwaukee, and elsewhere indicate that, with the natural lake waters, a Hazen-Williams *C* of 120 or more could be expected almost indefinitely.

The new specifications do not cover any lining other than cement mortar, although they do require that "no pipe for water works service shall be furnished without protective coating unless specifically ordered by the purchaser." This omission should be corrected. The gas industry, which is one of the sponsors of the ASA specifications for cast-iron pipe, is, of course, not interested in linings at all, but the water works industry is greatly concerned. Recently the AWWA Board of Directors, on the recommendation of its Water Works Practice Committee, authorized the setting up of a committee to develop a standard specification for coal-tar lining of cast-iron pipe.

Manager's Appraisal—*Wendell R. LaDue*

A paper presented by Wendell R. LaDue, Chief Engr. & Supt., Akron Bureau of Water and Sewerage, Akron, Ohio.

When a manager of a water utility views the new ASA standards for cast-iron pipe, he does so as a buyer, installer, and operator. When a cast-iron water main is laid, he wants to be assured, insofar as is possible, that the material he has purchased and installed possesses the long life he is justified in expecting of it on the basis of experience with the thousands of miles of cast-iron pipe laid during the past 250 years.

Three separate areas of responsibility appear to exist side by side:

1. *Pipe structure and design.* It is the responsibility of the engineer, in cooperation with the manufacturer, to develop a proper pipe structure, taking into account the quality of iron, pipe thickness, bell and spigot design, pipe coating and lining, and such factors as normal pressure, water hammer, soil and electrolytic corrosion, and pipe laying and jointing conditions.

2. *Material quality and manufacture.* It is the manufacturer's responsibility to cast pipe and fittings to meet the quality requirements for pipe and coating materials that have been set by both engineers and manufacturers and incorporated into standard specifications. Past experience of managers with pipe made with iron of inferior quality indicates the necessity for closer control in the preparation of the iron mix. The quality and quantity of scrap allowed, and the alloy determination and control of steel scrap, in particular, should be matters for specification. This reference to metallurgy appears necessary if the qualities that have made cast iron so reputable are to be attainable in present-day practice.

3. *Pipe laying and jointing.* The manager or operator should expect that, having determined the normal requirements of pressure, he will be justified in accepting material that has been cast, lined, and coated under standard specifications for use in normal conditions, whether he employs lead, lead substitute, or cement for jointing material. His responsibility lies in selecting the proper class of pipe required for the pressure and service, and in assuring proper excavation, pipe-laying, and backfilling procedure, as far as is practical. He should use judgment and engineering knowledge in his selection and utilization of jointing material. He must be assured that his pipe-laying

crews are thoroughly familiar with the use, limitations, and handling of the various materials. A proper installation is essential.

Bell and Spigot Design

Specifically the manager is presently involved in the question which emanates from nonuniformity in bell and spigot dimensions. Practically every large city possesses a distribution system made up of a mixture of pit-cast pipe, pipe centrifugally cast in metal molds, pipe centrifugally cast in sand-lined molds, and fittings cast in sand-lined molds. Interchangeability is desirable. The manager must be assured that the interior dimensions of the bells and the outside dimensions of the spigots (including beads) will permit adequate joint space. If not, he faces major problems in the laying of new mains and the inevitable repairs.

Class *D* fittings are often used on Class *B* pipe for mains larger than 12 in. In these instances, the spigot end of the fitting is too large for the pipe bell and usually requires the bead to be chipped off. Even then, the annular space may be too small for a proper joint. On the other hand, the larger bell of the fitting allows too much jointing space when used with centrifugal pipe. The latter fault may be corrected by ordering special Class *D* fittings with Class *B* bells. It seems fair, however, to ask why Class *D* fittings are necessary. Apparently Class *B* fittings as designed are inadequate for the pressures to be encountered in Class *B* or equivalent pipe. The investigation of a standard bell design appears desirable.

In recent years discussions on lead-substitute joint material have brought out the opinion that numerous pipe failures may have resulted from the cracking of bells, through faulty bell design, faulty joint material, or both. A few years ago the manufacturers of metal-mold centrifugally cast pipe began furnishing pipe with a new bell along the lines of that set up in the A21.6 specifications. This bell was heavier than, and the profile was radically different from, the old bell and may have represented the answer to the problem of providing greater strength. In any event, the manager is anxious to know whether pit-cast pipe and fittings and centrifugally cast pipe have bells of strength adequate for the service for which they are intended. The manager reasonably expects them to meet that qualification.

It would be interesting to know whether the revision in the dimensions of metal-mold centrifugal pipe resulted from: [1] a study of the initial tension in centrifugal pipe, indicating a need for additional strength regardless of the type of joint material; [2] the increased use of lead-substitute jointing material, creating stresses in excess of those developed in lead joints; or [3] mechanical calking of lead joints, creating stresses greater than those of hand-calked joints. For this particular type of pipe, a combination of all three of these reasons may have been involved, but what of sand-mold centrifugal pipe and pit-cast pipe bells?

It is believed that it would be worth while for a task group to investigate the question of pipe bells and spigots, covering such items as: [1] dimension of sockets; [2] spigot beads; [3] proper joint space for (a) lead, (b) lead substitute, and (c) cement mortar; [4] profile of outside of bell; [5] use of Class *D* fittings with Class *B* (or equivalent) pipe larger than 12 in. in diameter; and [6] development of good-practice standards for harnesses to be used on pipe layouts involving bends. (With

the use of centrifugally cast pipe, lugs are not possible.)

The manager is interested in the answers to all these questions. He is also intensely desirous that cast-iron pipe should continue to merit the reputation for long life acquired over the centuries. The new A21 specifications are an element in the attempt to achieve perfection.

APPENDIX

List of Committee A21 Specifications

The following specifications have been adopted by the American Standards Assn. after approval by the four sponsoring societies—American Gas Assn., American Society for Testing Materials, American Water Works Assn., and New England Water Works Assn.:

ASA Designation	AWWA Designation	Journal AWWA		Subject of Specification
		Issue	Page	
A21.2–1953	C102–53	Apr. 1953*	404	Cast Iron Pit Cast Pipe for Water or Other Liquids
A21.3–1953				Cast Iron Pit Cast Pipe for Gas
A21.4–1953	C104–53	Apr. 1953*	404	Cement Mortar Lining for Cast Iron Pipe and Fittings
A21.6–1953	C106–53	Feb. 1953	189	Cast Iron Pipe Centrifugally Cast in Metal Molds, for Water or Other Liquids
A21.7–1953				Cast Iron Pipe Centrifugally Cast in Metal Molds, for Gas
A21.8–1953	C108–53	Feb. 1953	207	Cast Iron Pipe Centrifugally Cast in Sand-lined Molds, for Water or Other Liquids
A21.9–1953				Cast Iron Pipe Centrifugally Cast in Sand-lined Molds, for Gas
A21.10–1952	C110–52	Nov. 1952	1065	Short-Body Cast Iron Fittings, 3 Inch to 12 Inch, for 250-psi Water Pressure Plus Water Hammer
A21.11–1953	C111–53	Apr. 1953	431	A Mechanical Joint for Cast Iron Pressure Pipe and Fittings

* Summary of revisions; the changes were not extensive enough to warrant republication of the complete text of the specifications in the Journal.

The above list covers the full scope of Committee A21 except for the revision of the American Recommended Practice Manual for the Computation of Strength and Thickness of Cast Iron Pipe—ASA A21.1–1939 (AWWA C101–39) and the specifications for large fittings for water. The revision of the manual is well along, but the specifications for large fittings have not yet been formulated. Much study has been given to large fittings, and a good many have been tested. The war interrupted this work, but the producers have started a new testing program, and these specifications should again begin to make progress.

Mechanism of the Internal Corrosion of Water Pipe

By Rolf Eliassen and James C. Lamb III

A paper presented on May 12, 1953, at the Annual Conference, Grand Rapids, Mich., by Rolf Eliassen, Prof. of San. Eng., and James C. Lamb III, Research Asst.; both of Massachusetts Inst. of Technology, Cambridge, Mass.

IRON occurs in nature in the form of an oxide or hydroxide, and the metal is produced through reduction of the ore. Corrosion may be considered as the reverse of this process, as iron is unstable in a corrosive environment and tends to revert to the more stable oxides.

The tendency of a metal to go into solution, or to corrode, is indicated by its electrode potential in that solution. In order to provide a standard basis for comparing the solution tendencies of the various metals, a metal ion "activity" of 1 mole per 1,000 g of water and a temperature of 25°C have been assumed in the preparation of the electromotive force series. In the abbreviated emf series presented in Table 1, the potential of hydrogen is taken as zero and all other potentials are referred to this value (*1, 2*). The metals are listed in order of decreasing solution tendency (increasing nobility of potential). The potential, E, of a metal under other conditions of temperature and metal ion activity may be found through the use of the Nernst equation:

$$E = E_0 - \frac{RT}{nF} \log_e (M^{++})$$

in which M^{++} is the metal ion activity in solution (gram-moles of metal per 1,000 g of water, multiplied by the activity coefficient); R is the gas constant, in joules; T is the absolute temperature (Kelvin); n is the number of electrons participating in the reaction; E_0 is the potential, in volts, of the metal at 25°C with unit metal ion activity; and F equals 1 faraday equals 96,500 coulombs per equivalent.

At 25°C, this equation may be expressed:

$$E = E_0 - \frac{0.059}{n} \log_{10} (M^{++})$$

There has been a tendency to use the emf series as though it were inflexible, each metal displacing from solution all metals below it in the series. This condition is usually true for metals widely separated in the series, but it should not be assumed to obtain in all instances. Changes in the potentials of metals in dilute solutions, such as are normally encountered in water works practice, may result in radical changes in the order of potentials given in the emf series.

Such a change occurs, for example, in the iron-zinc system. Zinc is normally anodic (more active potential) to

iron, and is used in many piping systems as a sacrificial protective coating for iron. In fresh water with a temperature higher than 150°F, however, it becomes cathodic (more noble potential) to iron and is no longer sacrificially protective (*2*). The effective potential of a metal also may be varied by reactions with elements in a given environment. It is evident that the emf series, calculated for unit metal activity, cannot be applied directly to determine the potential of a metal under the conditions normally found in water works practice.

TABLE 1

*Electromotive Force Series**

Electrode Reaction	Standard Electrode Potential (E_0), 25°C
$Ca = Ca^{++} + 2e^-$	−2.87
$Na = Na^{+} + e^-$	−2.712
$Mg = Mg^{++} + 2e^-$	−2.34
$Al = Al^{+++} + 3e^-$	−1.67
$Zn = Zn^{++} + 2e^-$	−0.762
$Cr = Cr^{+++} + 3e^-$	−0.52
$Fe = Fe^{++} + 2e^-$	−0.440
$Ni = Ni^{++} + 2e^-$	−0.250
$Sn = Sn^{++} + 2e^-$	−0.136
$Pb = Pb^{++} + 2e^-$	−0.126
$H_2 = 2H^{+} + 2e^-$	0.000
$Cu = Cu^{++} + 2e^-$	0.345
$Ag = Ag^{+} + e^-$	0.800
$Pt = Pt^{++} + 2e^-$	1.2

* Signs of potential employed by the American Chemical Society are opposite to those of this table.

A galvanic series is one in which metals are arranged in their usual electropotential sequence in a given environment. Therefore, although there is only one emf series, there may be many galvanic series, each applying to a given set of environmental conditions. In a galvanic series, like the abbreviated example in Table 2, actual potential values are not given, as these vary widely with different environmental conditions (*1, 2*). Metals that are grouped together in a galvanic series have little tendency to form galvanic cells, while metals that are widely separated have a great tendency to form such cells when used together.

Corrosion Cells

Many kinds of electrolytic cells are capable of causing the corrosion of metal, but those most commonly encountered in practice may be divided into a few basic types: impressed-current cells, galvanic or differential-metal cells, concentration cells, differential-aeration cells, differential-temperature cells, and differential-stress cells.

TABLE 2

Galvanic Series of Metals and Alloys

Corroded end (anodic or least noble)	Magnesium
↓	Zinc
	Aluminum 2S*
	Steel or iron
	Cast iron
	Lead
	Tin
	Brasses
	Copper
	Bronzes
	Chromium-iron (passive)
↑	Silver
Protected end (cathodic or most noble)	Graphite
	Gold
	Platinum

* "Commercial pure" aluminum.

Impressed-current cells. It is well known that, in an impressed-current cell (Fig. 1), the current flow between the electrodes results in a loss of metal from the anode in accordance with one of the following reactions, depending upon the current density:

$$Fe^0 \rightarrow Fe^{++} + 2e \quad \ldots\ldots (1)$$

or:

$$Fe^0 \rightarrow Fe^{+++} + 3e \ldots\ldots (2)$$

The rate at which the metal passes into solution is directly related to the rate of current flow between the electrodes. Faraday's law states that the passage of 1 faraday of electricity (96,500 amp-sec or coulombs) through an electrolytic solution produces one chemical equivalent of some chemical change at each electrode. Therefore, the passage of 1 faraday of electricity between the

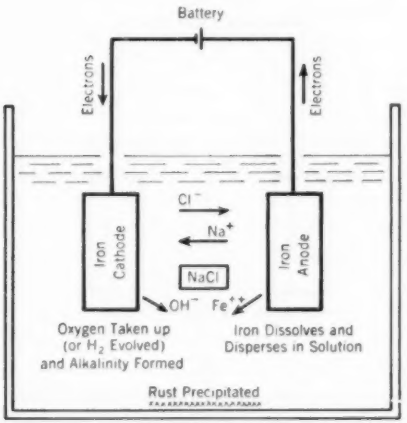

Fig. 1. Impressed-Current Cell

The current flow between the electrodes results in a loss of metal from the anode.

electrodes in Fig. 1 must cause one chemical equivalent of iron to enter solution from the anode.

One chemical equivalent of change is also produced at the cathode for each faraday of electricity passing through the solution. The primary reaction at this electrode involves the removal of electrons from the metal through neutralization of hydrogen ions in solution:

$$2H^+ + 2e \rightarrow 2H^0 \ldots\ldots (3)$$

This reaction results in the formation of atomic hydrogen, which tends to plate out on the metal. The layer of atomic hydrogen on this electrode tends to interfere with the transfer of electrons from the metal to the solution and, therefore, must be removed in order for the reaction to proceed. This may be accomplished through the formation of hydrogen gas:

$$2H \rightarrow H_2 \uparrow \ldots\ldots\ldots (4)$$

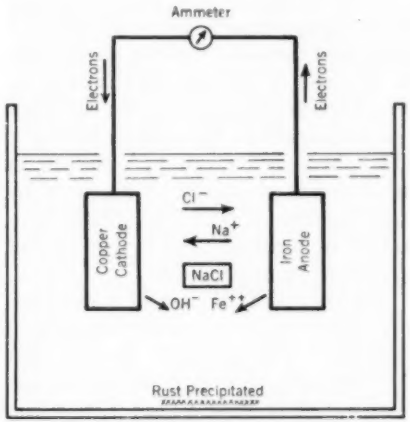

Fig. 2. Galvanic Cell

The reactions at the electrodes are identical with those in the impressed-current cell, but the current flow is due to the difference in the electrode potentials rather than to an external source.

or through reaction between the atomic hydrogen and chemicals in solution in the water. The most common reaction of this type involves the atomic hydrogen and oxygen in solution in the water:

$$4H + 2O_2 \rightarrow 2H_2O \ldots\ldots (5)$$

Other possible types of reactions between hydrogen and the oxygen in so-

lution have been suggested (*1–4*). The neutralization of hydrogen ions in the solution at the cathode results in the production of alkaline conditions in the vicinity of this electrode. The metal ions or salts entering solution from the anode react with alkalinity and oxygen in solution to form iron oxides, known as rust. These oxides may be formed in the vicinity of the anode or cathode, or in a location remote from either electrode.

The potential of a metal in water may be changed through the application of impressed currents, causing an increase or decrease in the rate of corrosion of the metal, depending upon the direction and magnitude of the applied emf (*2*). This phenomenon can be observed in the external corrosion of pipelines by stray currents and in the cathodic protection of pipeline exteriors and other structures by applied emf.

The corrosion of iron in water usually occurs in the absence of impressed currents. Whitney (*5*) showed that the corrosion of iron in water is electrochemical in nature, and Evans and Hoar (*6*) demonstrated that there is a direct relationship between the current flowing between anodes and cathodes on a metal surface and the weight of metal lost from that surface.

Galvanic cells. The emf and galvanic series show that, when different metals are introduced into a given environment, they have different tendencies to corrode, and display different potentials. Figure 2 illustrates such a situation, with iron and copper immersed in the same aqueous solution. Examination of a galvanic series (Table 2) reveals that copper may be expected to display more noble (cathodic) potential than iron. If the two metals are connected electrically, the difference in potentials between the iron and copper results in a flow of current between the electrodes. This may be demonstrated by connecting the two electrodes through an ammeter, as shown, and measuring the galvanic current flow.

In the cell shown in Fig. 2, the iron has the greater tendency to pass into solution, leaving electrons at the metal surface. These electrons pass through the metallic portion of the circuit to the copper electrode and are transferred from the metal to the solution by neutralization of hydrogen ions in the solution. The atomic hydrogen is removed from the copper through the formation of hydrogen gas or reaction with oxygen in solution. In this cell, the iron serves as the anode (electrode at which oxidation takes place), while the copper functions as the cathode (electrode at which reduction takes place). The current flow that accompanies the loss

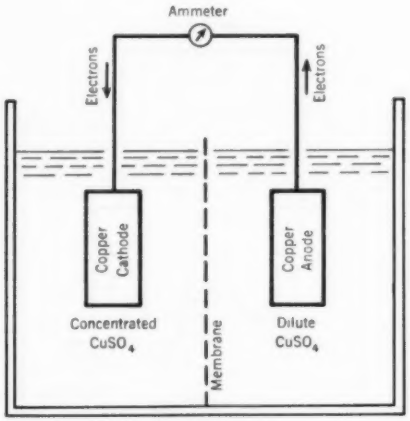

Fig. 3. Concentration Cell

In this type of corrosion cell, the difference in electrode potentials results from the difference in metal ion concentrations in the solutions.

of metal from the anode is generated by the difference in potentials between the electrodes in the galvanic cell rather than by an external source of emf as in the impressed-current cell. Therefore, the galvanic cell in Fig. 2 can be considered—and, in fact, is—nothing more or less than a battery. The reactions taking place at each electrode are identical with those described above for the impressed-current cell.

Concentration cells. From the Nernst equation previously given, it can be seen that the potential of a metal in a solution varies with the concentration of its ions in that solution. As the concentration of metal ions in solution increases, it becomes more difficult for additional metal to enter the solution as ions. Therefore, a metal can be expected to display a more noble potential in the presence of a high metal ion concentration. Figure 3 shows two identical copper electrodes immersed in solutions of different concentrations of copper sulfate. As these electrodes are exposed to different concentrations of copper ions, they have different potentials. The electrode in the more concentrated solution has a more noble potential and acts as the cathode in the corrosion cell, while the other electrode functions as the anode.

The potential of a metal in solution is affected by the concentration of ions other than metal ions. For example, a concentration cell similar to the one in Fig. 3 can be prepared by using two sodium chloride solutions of different strength. This effect can also be observed with metals immersed in solutions of different substances (acids, bases, salts, or gases).

Differential-aeration cells. A differential-aeration cell is a special type of concentration cell which is of particular significance in the water works field. The rate of the chemical reaction between the oxygen in solution and the hydrogen atoms on the metal depends upon the rate of access of oxygen to the metal surface. Therefore, if one electrode of a corrosion cell receives oxygen at a higher rate than the other, the polarizing layer of hydrogen on this electrode is removed more rapidly. The rapid removal of hydrogen facilitates the transfer of electrons from the metal to the solution at that point, and this area of the metal becomes the cathode of the corrosion cell. The electrode that receives less oxygen becomes the anode of the differential-aeration cell. This electrode suffers an increase in corrosion rate owing to the increased rate of depolarization at the cathode. The significance of this type of corrosion cell in water works practice will be discussed more fully later.

Differential-temperature and differential-stress cells. Differences in temperatures and stresses of metals may result in the formation of corrosion cells. These types of cells may be important in initiating corrosion, but their effects are usually obscured by other, more significant kinds of corrosion cells. Therefore, on a long-term basis, differential-temperature and differential-stress cells are of relatively little importance, under the conditions usually found in water works.

Formation of Corrosion Cells

For the sake of clarity, the electrodes in the cells considered in the preceding section were assumed to be individual pieces of metal. The corrosion of a single submerged metallic object results from the formation of anodes and cathodes on the surface of the metal. Figure 4 shows, schematically, a typical

corrosion cell on the surface of a submerged sheet of iron. The anode and cathode of this cell are short circuited by the body of metal. It will be noted that the cell and the electrode reactions shown in Fig. 4 do not differ basically from those which have been discussed previously. The surface of a large section of metal might be covered by many such corrosion cells. The presence of local anodes and cathodes on the surfaces of corroding metals has been demonstrated, and it has been shown that

gen acts as the cathode in the corrosion cell, while the portion shielded from oxygen becomes the anode.

Figure 5f shows a galvanic cell caused by connecting pipes made of different metals. Copper and brass are cathodic to iron, and, therefore, the iron pipe corrodes while the copper or brass pipe acts as the cathode in the corrosion cell. Figure 5g shows conditions under which an electrolyte concentration cell may be encountered in the external corrosion of pipelines passing through soils

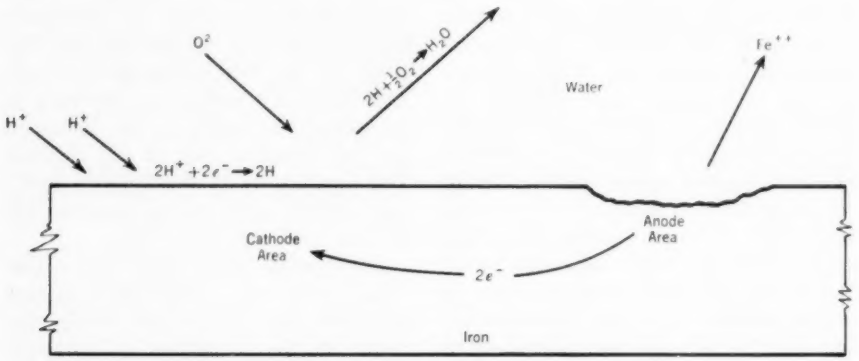

Fig. 4. Corrosion Cell on Surface of Submerged Iron

The surface of a large section of metal may be covered by many such cells, the electrode reactions of which are similar to those discussed previously.

the amount of current flowing between the electrodes and the weight of metal lost can be definitely correlated (*6, 7*).

The formation of a corrosion cell on the surface of a metal may be due to differences in metal composition, electrolyte concentration cells, or differential-aeration, -temperature, or -stress cells. Figure 5 shows a few typical examples of how such cells may be formed in practice. The first five (Fig. 5a–5e) are examples of differential-aeration cells. In each instance, the portion of the metal that has freer access to oxy-

or waters that vary widely in chemical characteristics.

Finally, Fig. 5h illustrates a common example of corrosion by impressed current. If the water main may become part of the return circuit to a power plant furnishing electricity for a streetcar system, the portion of the pipe where the current passes from pipe to ground suffers an increase in corrosion rate. The corrosion rate of that portion of pipe at which no interchange of current takes place between pipe and ground is not affected, and the internal

corrosion of the pipeline is likewise unaffected.

The types of cells capable of causing corrosion have been discussed individually, but it must be stressed that two or more varieties may tend to occur simultaneously. For example, the concentration of metal ions under a tubercle (Fig. 5c) could be expected to be higher than in the water surrounding the tubercle. Therefore, consideration of the relative concentrations of metal ions would indicate a tendency toward the formation of a corrosion cell in which the area of metal under the tubercle would act as the cathode. The differential-aeration cell formed by the action of the tubercle in shielding a portion of the metal from oxygen tends, however, to result in the formation of a cell in which the area of metal outside the tubercle acts as the cathode and the area under the tubercle serves as the anode.

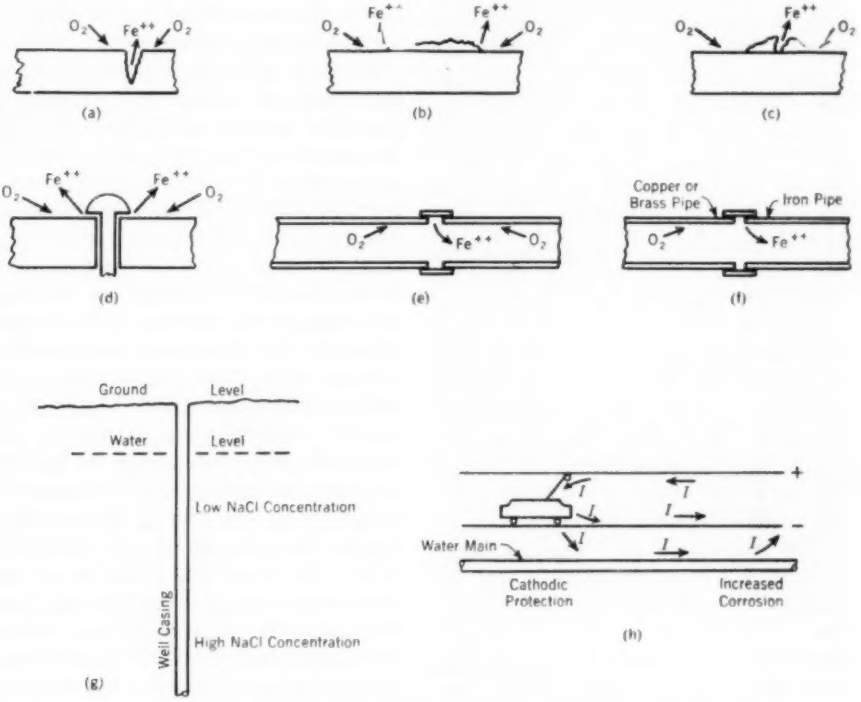

Fig. 5. Typical Corrosion Cells Found in Practice

Key: (a) pit or depression; (b) mill scale or corrosion products; (c) biological growth; (d) rivet or bolt; (e) pipe coupling (same metals); (f) pipe coupling (dissimilar metals); (g) well casing in water with varying salt content; (h) stray-current corrosion. The first five are examples of differential-aeration cells; the remaining three illustrate, respectively, galvanic, concentration, and impressed-current cells.

Rate of Corrosion

It has been pointed out that the rate of corrosion of a metal in aqueous solution is a function of the rate of current flow between anodes and cathodes on the surface of the metal. The reactions taking place in a corrosion cell have been presented in the preceding sections. It is evident that, in order for corrosion to take place (Reaction 1), the electrons left on the metal by this reaction must be removed (Reactions 3–5). Otherwise, a counter, or back, emf will be built up on the metal, and the corrosion will be stifled. Therefore, in a corrosion cell, the anode and cathode reactions must proceed at the same rate. Any reduction in the rate of the reaction at either electrode must result in a corresponding reduction in the rate of current flow between the electrodes and, hence, in the rate of corrosion of the metal. In practice, the rate of corrosion may be controlled by reducing the rate of the anode reaction, the cathode reaction, or both.

The removal of the polarizing layer of hydrogen from the cathode may be accomplished through hydrogen evolution (Reaction 4) or through oxygen depolarization (Reaction 5). It has been shown by past investigators that, in neutral or mildly alkaline waters, corrosion with evolution of hydrogen at the cathode is negligible, although the relative positions of iron and hydrogen in the emf series might lead to the supposition that the corrosion of iron should be accompanied by continuous evolution of hydrogen. The explanation is that resistance or "overvoltage" must be surmounted before hydrogen can be evolved as a gas from a metal surface. In neutral or mildly alkaline waters, the overvoltage is too high to allow the escape of appreciable amounts of hydrogen gas from iron cathodes. As the pH of a water decreases below a value of approximately 4.0, the hydrogen ion concentration is increased to such an extent that hydrogen evolution is greatly facilitated, and the formation of this gas becomes a major cathodic reaction.

Because the waters encountered in municipal and industrial systems are generally neutral or slightly alkaline, the amount of corrosion due to hydrogen evolution is of minor significance—approximately 3 per cent, according to Speller (*2*). Therefore, the primary cathodic reaction in these systems must be the removal of hydrogen by reaction with oxygen in solution in the water (Reaction 5). The anode reaction rate is much more rapid than the depolarization reaction rate at the cathode (*2*). As both reactions must proceed at the same rate, it is evident that the rate of corrosion of iron in natural waters is controlled by the rate of oxygen supply to the cathodes of the corrosion cells. The latter rate is influenced by the concentration of oxygen in solution, the rate of flow and turbulence of the water, and the presence of films of oxides or inhibitors on the metal surface. Within the range of oxygen concentrations normally found in municipal and industrial waters, the rate of corrosion increases directly with the rise in oxygen concentration.

Uhlig (*8*) has stated that: "All iron and steel, regardless of minor variations of composition or structure, corrode at the same rate in natural waters." This fact is of great significance to the water works industry, which uses many types of iron and steel pipes for various reasons, some realistic and others not.

The formation of films on the surfaces of metals has a significant effect on their corroding characteristics. The films formed on metals may include layers of hydrogen or oxygen, films formed by chemical reaction between corrosion products and elements of the corrosive environment, and films formed by inhibiting agents added to the corrosive medium. Film formation may occur preferentially at either anodes or cathodes of corrosion cells, or over the entire surface of the metal. Films on the cathodes of corrosion cells may interfere with the transfer of electrons from the metal to the solution. The formation of these films may result from the electrodeposition of positively charged ions or colloidal particles on the cathode, from sorption of chemicals on the metal surface, or from the reaction of some chemical in solution with the alkalinity produced at this electrode, resulting in the formation of an insoluble precipitate on the metal.

Anode films may be formed through electrodeposition of negatively charged ions or colloidal particles on this electrode, through sorption of chemicals on the metal surface, or through the production of an insoluble precipitate by reaction between the iron entering solution and chemicals in solution. The formation of an anode film may result in the effective separation of the metal from the water at the anode, stifling the anode reaction.

Under certain conditions, film formation on a metal may be accompanied by a radical change in the potential of that metal to a more noble value. When a metal undergoes a sharp reduction in corrosion rate, accompanied by a shift in potential to a more noble value, it is said to be "passive."

Figure 6 shows the effect of the pH of the water on the corrosion rate of mild steel in the absence of the formation of protective coatings (*9*). The rate is essentially constant in the range of pH 4–10 at 22°C. In this range, the predominant cathodic reaction is oxygen depolarization, and the corrosion rate is determined by the rate of supply of oxygen to the metal surface. As the pH of the water is decreased below 4, hydrogen evolution becomes a major cathodic reaction. The increased corrosion rate at low pH values can be attributed to increased hydrogen ion concentration in the solution and the dissolving action of the water on any protective layers of corrosion products on the metal. As the pH is increased above 10, a protective layer of corrosion products is formed on the metal, or the surface reaction rate of the iron becomes lower, resulting in passivity of the metal and a decrease in the corrosion rate. The chemicals present in natural waters may have a great effect upon the shapes of the curves in Fig. 6, through reaction with corrosion products and formation of protective coatings.

Polarization

In a corrosion cell, the driving force for the electrical current flow between the electrodes is the difference in potential between the anode and the cathode of the cell. From Kirchoff's second law:

$$\Sigma \text{emf} = \Sigma IR$$

or:

$$E_c - E_a = IR_e + IR_m$$

in which R_e is the resistance of the electrolytic portion of the circuit; R_m is the resistance of the metallic portion of the

circuit; E_c is the effective (polarized) potential of the cathode; E_a is the effective (polarized) potential of the anode; and I is the current flow between the electrodes.

The potentials of anodes and cathodes in corrosion cells may vary with the current flow through the cells. This effect is known as polarization and is comparable to friction in a mechanical or hydraulic system. As the current flow through a corrosion cell increases, the potentials of the anode and cathode tend to approach a common value. Polarization of both electrodes would result in a shift in the anode potential in the cathodic direction and a shift in the cathode potential in the anodic direction. Therefore, the potential difference between the electrodes in a corrosion cell through which current is flowing is usually less than the difference in the open-circuit potentials, or potentials of the electrodes with no current flowing. An increase in the degree of polarization of either electrode results in a decrease in the potential difference between the electrodes (or driving force for the corrosion process) and, thus, in a decrease in the rate of current flow in the cell.

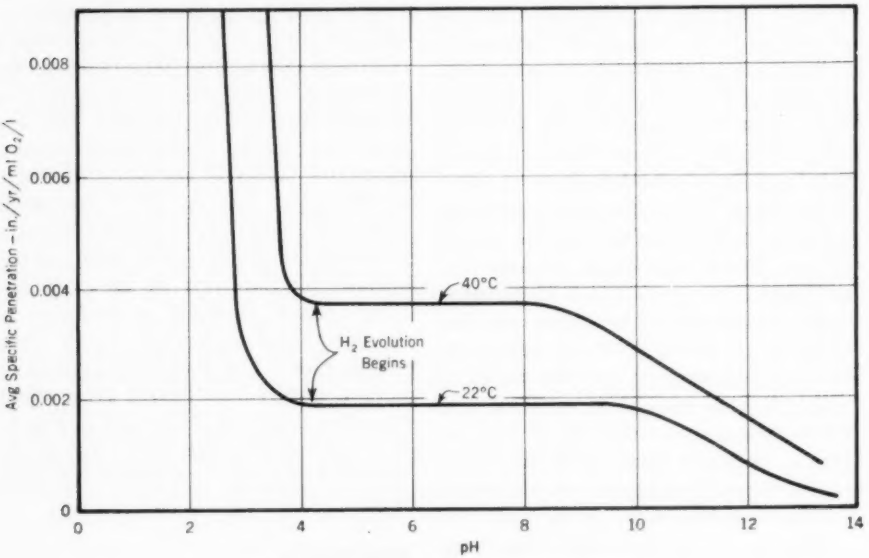

Fig. 6. Effect of pH on Corrosion of Steel

In the pH range 4–10, the corrosion rate depends on the rate of oxygen supplied to the metal surface. Above pH 10, the formation of a layer of corrosion products leads to passivity. Below pH 4, hydrogen evolution becomes a major cathodic reaction.

The polarizing characteristics of separate anodes and cathodes under a given set of conditions may be determined by varying the rate of current flow between the electrodes (by varying R_m) and measuring the potential of each electrode against that of a stand-

ard reference cell. In Fig. 7 is shown a typical pair of polarization curves, indicating the potentials of the anode and cathode of a corrosion cell at various values of current flow between the electrodes. The points at which the curves intercept the ordinate axis represent the open-circuit potentials of the electrodes (no current flowing in the corrosion cell). The intersection of the curves gives the corrosion potential and the corrosion current with the electrodes short-circuited, which is usually the situation in practice. The curves represented by the solid lines are separated by a distance equal to IR_m. These are the curves that would be obtained by measuring the potentials of the electrodes against a "remote" reference cell, or a reference cell located midway between the electrodes. The broken lines in Fig. 7 are those which would be obtained through the use of probe electrodes, located in the immediate vicinity of the respective corrosion cell electrodes. These curves are separated by a distance equal to $IR_e + IR_m$.

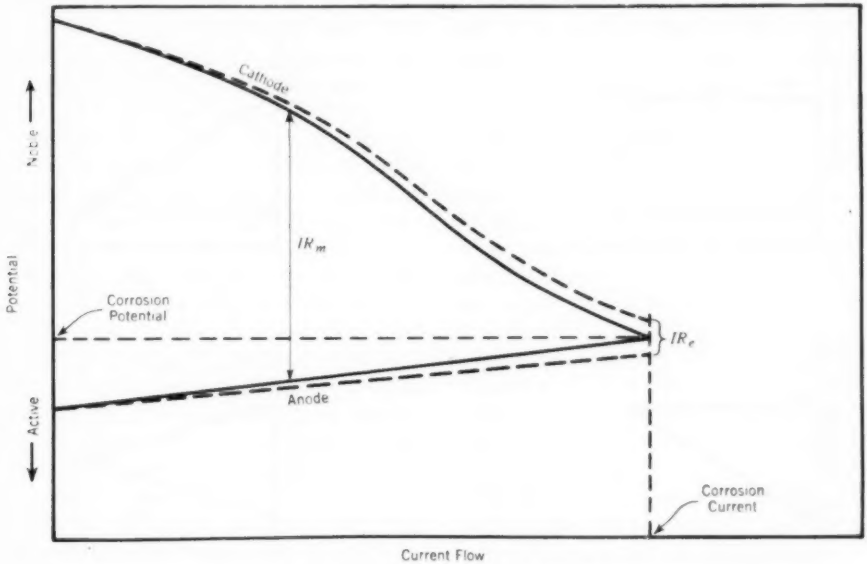

Fig. 7. Typical Polarization Curves

The solid lines represent the curves that would be obtained if the electrode potentials were measured against a "remote" reference cell; the broken lines indicate the curves resulting from the use of "probe" electrodes, located close to the respective corrosion cell electrodes.

It has been stated that the rate of corrosion may be controlled by the rate of the cathode reaction, the anode reaction, or both. Altogether, four types of control are possible in corrosion cells. These are illustrated in Fig. 8. Figure 8a represents the limiting case of "resistance control," in which the current flow between the electrodes has no ef-

fect on the potential of either of them; the current flow in the corrosion cell is limited by the IR_e and IR_m of the system, and the potential of each electrode remains constant at the value of the open-circuit potential for that electrode. This situation would never occur in water works practice. Figure 8b represents the case in which the current flow in the corrosion cell is limited by

It has been pointed out that, in aqueous solutions with no inhibitors present, the anode reaction rate in the corrosion of iron is very much faster than the depolarization reaction rate at the cathode. In neutral or slightly alkaline waters, the rate of corrosion is almost completely governed by the rate of supply of oxygen to the cathode. Therefore, in most municipal and industrial

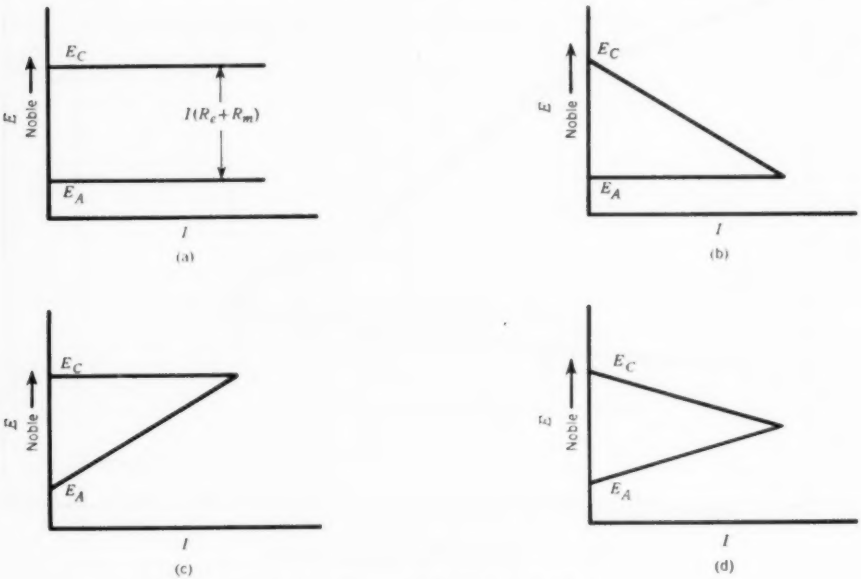

Fig. 8. Types of Corrosion Control

Key: (a) resistance control; (b) cathodic control; (c) anodic control; (d) mixed control.

the polarization (change in potential with current flow) of the cathode. In this instance, the corrosion is said to be under "cathodic control." Figures 8c and 8d show polarization curves that might be obtained when the rate of corrosion is controlled by polarization of the anode ("anodic control") or of both electrodes ("mixed control").

water systems, the corrosion is under primarily cathodic control, as illustrated in Fig. 8b. The rate of corrosion is governed by the degree of polarization of the cathode.

Distribution of Corrosion

The factors affecting the overall rate of corrosion of iron in water have been

discussed. Other factors of equal significance are those which influence the distribution of corrosion occurring; the corrosion may take place uniformly over the entire metal surface or be localized, with the entire loss of metal confined to a relatively small area. The life of a metallic structure in water is determined, to a large extent, by the rate of penetration of the structure by corrosion. Localized attack may lead to rapid failure of the structure, although a relatively small proportion of the metal has been lost to solution.

As the rate of corrosion of iron in water is usually controlled by the rate of the cathode reactions, the formation of a protective coating that only partially shields the anode of a corrosion cell from the corrosive medium may have little or no effect on the rate at which metal passes into solution. In these circumstances, incomplete shielding of the anode may lead to a reduction in the effective anode area and to an increased rate of penetration of the metal. This results in more rapid failure of the structure.

Chemical deposits, as well as deposits of biological organisms on the surface of a metal, may result in the formation of tubercles. Tubercles restrict the access of oxygen to the surface of the metal, thereby establishing differential-aeration cells. The metal under a tubercle undergoes pitting attack, while the metal surrounding the tubercle serves as the cathode of the corrosion cell. The anaerobic conditions within tubercles favor the growth of the sulfate-splitting type of bacteria, even though oxygen may be present in the water outside the tubercle. These organisms are capable of utilizing cathodic hydrogen, thus causing microbiological depolarization, and they produce hydrogen sulfide, which reacts with the ferrous metal to form ferrous sulfide (*2*).

The formation of protective coatings on the cathode of a corrosion cell under cathodic control results in an overall reduction in the rate of metal loss without increasing the rate of penetration of the metal, because the effective area of the cathode is reduced. The formation of protective films on the cathode tends to restrict the access of oxygen to this electrode. Simultaneous removal of corrosion products from the anode of the corrosion cell would result in the formation of a differential-aeration cell, with the shielded cathode becoming the anode of the new cell, while the area that was originally anodic but now has freer access to oxygen would serve as the cathode. It is evident that such conditions favor continuous reversals of the potentials of anodes and cathodes on the metal surface. This situation results in a uniform attack of the metal surface over a period of time.

In solutions of low conductivity, the anodes and cathodes are limited in size by the resistance of the electrolytic portion of the corrosion cell. The surface of iron in a water of low conductivity is covered by a large number of small, evenly distributed anodes and cathodes, resulting in a relatively uniform attack on the metal surface. In a water of high conductivity, the cathodic area serving a given anode may be much larger, owing to the lower internal resistance of the corrosion cell. Under such conditions, there are fewer corrosion cells on a given area of metal, and localization of corrosion is increased (*2*).

Stray electrical currents cause localization of corrosion at areas where the

current leaves the pipe. Localized corrosion may also occur near the waterline in storage tanks.

Summary

The mechanism of the internal corrosion of water pipes is of a very complex nature. The rate and distribution of pipeline corrosion are affected by many variables, a few of which have been discussed briefly.

The evaluation of existing corrosion inhibitors and the development of more effective means for reducing pipeline corrosion are problems of prime significance to the water works profession. The solution of these problems can be accomplished only after a thorough understanding of the mechanism of corrosion and corrosion inhibition has been obtained through extensive research programs. In the light of such knowledge, it should be possible to design laboratory and field tests to evaluate accurately the existing methods of reducing losses through corrosion, and to develop more efficient methods for controlling internal pipeline corrosion.

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Findings and Recommendations on Underground Waste Disposal

Task Group Report

A task group report presented on May 14, 1953, at the Annual Conference, Grand Rapids, Mich., by Norman F. Billings, Chairman, Task Group E4.C—Underground Waste Disposal and Control; Hydrogeologist, Michigan Water Resources Com., Lansing, Mich. Other members of the task group were: L. E. Blakeley, A. G. Fiedler, T. R. Lathrop, T. J. Powers, E. J. Schaefer, S. W. Wells, and C. V. Youngquist.

THE assignment of this task group has been to study the subject of industrial-waste disposal in or on the ground and assess its effects upon present or future ground water supply. A report was made in 1952 on findings up to that time, with special consideration of the Michigan situation (*1*). The task group felt that data then available did not present a complete picture of the nationwide ground water pollution situation, and further investigation was proposed. In deliberating methods for collecting additional data, there was a question whether anything would be gained by further refinement of the picture and whether the principles of ground water pollution control were not so simple and basic that they would apply regardless of further findings.

Following this line of thought, those facts which appear fundamental were selected and their practical significance was interpreted. This analysis suggested recommendations that seem not only eminently logical but also adequate for translation into statutory control measures. The task group has had recourse to studies conducted by the ground water pollution committee of the Michigan Section, AWWA, two members of which are included in the task group. Results of the task group analysis are herewith presented under the categories of findings, conclusions, and recommendations.

Findings

1. Although ground water pollution by industrial-waste disposal is reported as relatively minor in many states, and even nonexistent in some, it is, nevertheless, nationwide in distribution. Important areas of such pollution are found in the Far West, the South, the East, the glaciated midcontinent region, and some central states.

2. Pollution is reported to have resulted from a number of wastes, including natural and artificial brines, phenolic compounds, cleaning fluids, salts of heavy metals, picric acid, gasoline and other petroleum products, pickling liquors, fruit and vegetable cannery wastes, milk wheys, and spent cooling water.

3. Ground water pollution resulting from industrial wastes is generally a

local effect. The localities involved, however, tend to be urban and semi-urban in character, with high water demands.

4. The velocity of ground water movement through porous materials is very small—a few feet or inches per day. Thus, it may, and sometimes does, take years for wastes to move from the disposal site to water wells. Similarly, ground water pollution, once established, is likely to be very persistent.

5. Ground water flow through porous materials is laminar and smooth, not turbulent. Wastes that reach underground reservoirs do not move through the ground water; they move with it, somewhat as clouds move with the air. Thus, the opportunity for dilution is essentially limited to a narrow diffusion zone around the polluted body.

6. The route and time schedule of underground flow are not ascertainable in advance, because its direction and speed are susceptible to radical change under the influence of wells or other factors that influence hydraulic gradients.

7. Industry has been, is, and promises to continue expanding in all regions of the nation. This expansion is based upon the needs of national defense and domestic progress.

8. Industrial use of water is also steadily rising. Thus, areas in which water resources are available are assuming increasing attractiveness to industry, and the volume of waste water to be disposed of is growing.

9. In general, the discharge of polluting wastes into streams is meeting with increased resistance. The attractiveness of waste disposal into the ground, where possible, is thereby enhanced.

10. Lagooning and deep well disposal of industrial wastes appear to be increasing.

11. Some wastes are so potent that very small concentrations produce severe injury. For example, a fraction of a part per million of phenol will render water nonpotable, and similarly small amounts of hexavalent chromium will make it poisonous. Radioactive wastes are a special hazard.

12. Recharge of underground reservoirs originates in rain or snow. Liquid or soluble wastes disposed of on the ground have the same opportunity as rain and snow water to enter the underground formations. Wastes discharged into wells, pits, shafts, or tunnels may have an even better opportunity.

Conclusions

1. In this day of rapid development and change in industry and in the economic factors that determine its location, attempts by the present task group to anticipate long-range future industrial trends are not feasible. It would seem reasonable to conclude, however, that a potential hazard is generally to be expected wherever changing economics attracts water-using industry to ground water recharge areas.

2. Appraising the susceptibility of aquifers to pollution by industrial waste is essentially a matter for geologists.

3. As long as water-using industry continues to expand and as long as the public remains opposed to the pollution of surface waters, there will be a tendency to turn to underground methods of disposal.

4. The proper time to control underground pollution is before it occurs. If corrective measures are deferred until proof of actual damage is at hand, so much pollution is likely to have taken

place that restoration of purity will be difficult, costly, and slow, if possible at all.

5. Whether or not the ground waters in question are privately owned, their protection from pollution is a matter of legitimate public interest because the waters may be expected to move, naturally or under artificial influence, to other properties, public or private; because their direction of movement is not readily ascertainable or constant; and because, once polluted, they may remain so, to the detriment of other users and even future generations.

6. The rate of increase in ground water use indicates that full development of local ground waters may be expected within the foreseeable future throughout great portions of the nation. The problem of polluted ground waters cannot, therefore, be solved by abandoning them in favor of alternate sources.

Recommendations

1. Areas in which ground water pollution is not reasonably possible, owing to geological conditions, should be identified by the state geologists or other state-level geological authorities.

2. In all other areas, industry should be required by state law to serve notice of existing waste disposal into or on the ground. Such notice should go to a designated agency that is qualified and staffed to appraise the pollution potential of the disposal. Similar notice should be served for proposed new disposal.

3. The agency receiving notice should be authorized to issue and enforce orders to stop or restrict waste disposal into or on the ground, upon the showing of a reasonable possibility that such disposal may cause unwarranted damage to fresh ground waters.

4. A system of permits for new disposal should be established, and the administering agency should be empowered to qualify or refuse permits for such disposal upon a similar showing of reasonable possibility of damage.

5. Provisions should be made for recourse to the courts, within a stipulated period, by parties who may be aggrieved by such orders or permits. Review of fact, as well as of law, by the trial court should be permitted.

Reference

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Expenditure Control Through Responsibility Accounting

By T. M. McDaniel Jr.

A revision of a paper presented on Oct. 30, 1952, at the California Section Meeting, Pasadena, Calif., by T. M. McDaniel Jr., Arthur Andersen & Co., San Francisco, Calif.

A PRIMARY objective of every accounting system should be to provide all levels of management in an organization with information that will aid them in more effectively controlling their costs and operations. The accounting and reporting systems of many public utility companies fail to meet this objective. This failure is essentially due to the fact that most public utilities in this country are operating under uniform systems of accounts that usually emphasize the classification and reporting of expenditures as related to physical plant rather than to responsibility for the expenditure. These uniform classifications were established as a means of obtaining accounting information useful for regulatory purposes, with little regard for the needs of management.

For management purposes, there has been developed in recent years a system of public utility accounting that provides reports showing where the costs were incurred and who in the organization was responsible for their control. Management control is founded on these reports prepared upon a responsibility basis. After such summaries have been made, the expenditures can be reshuffled and resummarized in accordance with regulatory commission accounts. Under this system, however, reports are prepared in accordance with uniform classifications of accounts only when they are required by a regulatory agency.

A relatively new approach to accounting and reporting, this system must be tailored to fit the particular company organization concerned. By directly relating the reporting of expenditures to the individuals who are responsible for their control, the system aids the supervisor in controlling the costs for which he is responsible. Only controllable costs are reported; reports are not confused by the inclusion of bookkeeping allocations or other accounting complications.

A system of responsibility accounting, properly set up, provides all the features essential to effective budgetary control. Budgeting, itself, is simplified because costs are accumulated and reported by natural divisions of work. Variations from the budget can be traced to the individual work operations that occasioned them and to the persons responsible for them. This information assists in analyzing the reasons for the variations.

The tables and charts accompanying this article have been prepared to illustrate a system of responsibility accounting as it would be applied to a typical water utility. For the present purpose,

it is assumed that the "Representative Water Co." is operating under the uniform account classification prescribed by the National Assn. of Railroad and Utility Commissioners, although, of course, a uniform system prescribed by any state or regulatory agency could have been assumed instead.

Company Organization

A basic principle of responsibility accounting is that costs will be accumulated and reported by levels of responsibility within an organization. These levels are defined by a company's organization chart. Accordingly, any system of responsibility accounting must be built around the organization chart of the individual company involved.

Figure 1 depicts a condensed and simplified organization chart of the Representative Water Co. In this hypothetical company, there are four major departments (finance, personnel, operating, and commercial) each reporting to the president. The distribution division of the operating department has been shown in complete detail in Fig. 1, to serve as an example. It should, of course, be recognized that any other segment of the organization could equally well have been chosen for this illustration, and that, in a specific organization, the number of levels of responsibility may not be confined to the four indicated here.

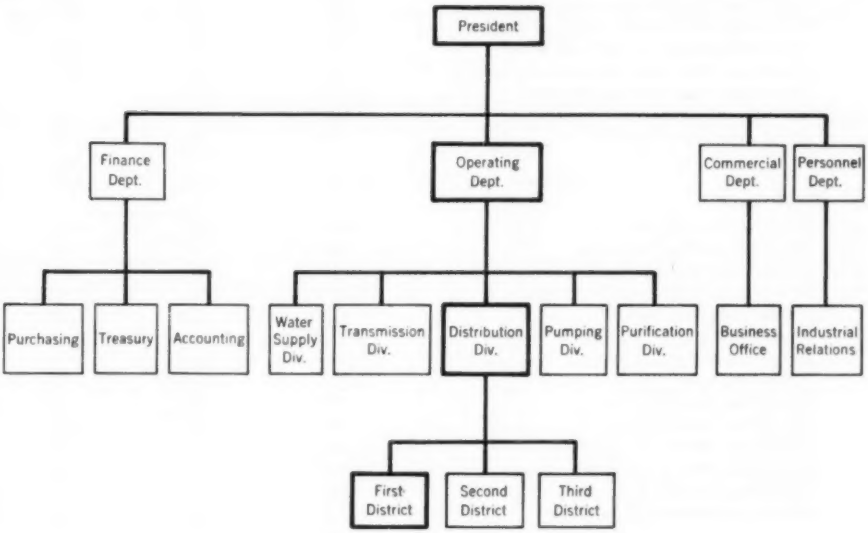

Fig. 1. Condensed Organization Chart

Examples of reports are given only for the sections heavily outlined. Reports for parallel sections follow similar principles.

It will be noted that, within the distribution division, there are three districts—first, second, and third—illustrating that, in this organization, responsibility has been assigned on a geographical as well as on an operational basis, with the geographical

TABLE 1

Responsibility Statement—Distribution Division, First District

Breakdown	Actual	Budget	Variation
Overhead			
Supervision	$ 982	$ 850	$ 132
Distribution engineering	1,332	1,320	12
General clerical expenses	1,550	1,460	90
Other overhead functions	105	200	(95)
Subtotal	3,969	3,830	139
Operation			
Inspecting distribution system	1,418	1,200	218
Investigating water leaks	521	300	221
Operating distribution system	859	920	(61)
Operating distribution reservoirs	1,642	1,620	22
Groundskeeping on rights of way	2,746	160	2,586
Hydraulic tests and flow measurements	457	350	107
Removing and resetting meters	1,723	1,650	73
Services on customers' premises	821	650	171
Other operating functions	572	360	212
Subtotal	10,759	7,210	3,549
Maintenance			
Maintaining exposed mains	1,040	680	460
Repairing main regulators	657	520	37
Repairing cast-iron mains	2,619	2,200	419
Repairing asbestos-cement mains	1,308	1,500	(192)
Repairing other mains	678	550	128
Transferring services to new mains	2,522	1,450	1,072
Repairing copper services	1,620	1,460	160
Repairing other services	1,213	1,260	(47)
Repairing main gate valves	377	390	(13)
Repairing meter boxes	708	500	208
Repairing meters in field	3,782	1,250	2,532
Repairing meters in shop	2,608	1,750	858
Repairing hydrants	562	550	12
Other maintenance functions	1,157	1,200	(43)
Subtotal	20,851	15,260	5,591
Total	$35,579	$26,300	$9,279

responsibility subordinate to the operational responsibility. In another organization, it might be desirable for this relationship to be reversed.

A series of reports in tabular form has been prepared to demonstrate the buildup from the lowest level of responsibility to the highest, with a final tie-in to the top income account. These reports for the supervisors at each level show the interrelationship of the various levels within the organization.

District and Division Reports

The first or lowest level of responsibility, in this instance, is the district of the distribution division. Table 1 is a responsibility statement prepared for the supervisor of the first district. Similar statements would, of course, be

prepared for the supervisors of each of the other districts. The report consists of a listing, by natural divisions of work, of all costs for which the district supervisor is responsible. These work operations, often called "functions," must be designed to fit the particular requirements of each individual department or organizational unit. The supervisor who is to be held responsible for costs determines just what breakdown of functions he needs in order to exercise effective control. The functions are described in terms that are understood by operating personnel and refer only to items of cost that can be controlled by them.

The grouping of functions under the captions of "overhead," "operation," and "maintenance" has no particular significance at this level of reporting other than to give the supervisor a quick, overall picture of his operations. As will be noted later, however, this segregation permits a ready tie-in from one level of reports to the next.

The total costs for which the supervisor of the first district was responsible amounted to $35,579. This sum, together with the total budget and budget variation amounts, will be carried forward to the report prepared for the next level of responsibility.

The distribution division, which is the second lowest level of responsibility, is made up of three districts. The division supervisor is responsible for the costs of each of these, as well as for division office costs. The responsibility report prepared for the division supervisor is shown in Table 2. It will be seen that the total costs for the first district ($35,579) have been carried forward from the first-level report prepared for the district supervisor. The total costs for the second and third districts have been carried forward from first-level reports prepared for those districts. Budget and variation amounts have also been brought forward for all districts.

Distribution division office costs, set forth separately above the individual district totals, include supervision, engineering, clerical, and other general expenses of the division which are the

TABLE 2

Distribution Division Summary, by District

Breakdown	Actual	Budget	Variation
Distribution division office			
General supervision	$ 1,400	$ 1,250	$ 150
Distribution engineering	1,620	1,500	120
General clerical expenses	1,235	1,120	115
Other general division expenses	216	250	(34)
Subtotal	4,471	4,120	351
District totals			
First district	35,579	26,300	9,279
Second district	27,963	24,490	3,473
Third district	21,542	20,450	1,092
Total	$89,555	$75,360	$14,195

direct responsibility of the division supervisor. These costs, combined with the total costs for each of the districts, equal $89,555, which is the total direct cost of operating the entire distribution division.

The distribution division supervisor also receives a supplemental report (Table 3) showing the total costs of operating the division in terms of work operation or function, without regard to individual district responsibility. It will be noted that the total costs ($89,555) are the same as in the preceding report. Table 3 tells the division supervisor the total costs of each operation for which he is responsible. It sets out clearly the relationship of over-

TABLE 3

Distribution Division Summary, by Function

Breakdown	Actual	Budget	Variation
Overhead			
Supervision	$ 3,627	$ 3,490	$ 137
Distribution engineering	4,721	4,150	571
General clerical expenses	4,715	4,200	515
Other overhead functions	676	500	176
Subtotal	13,739	12,340	1,399
Operation			
Inspecting distribution system	4,181	3,820	361
Investigating water leaks	1,322	1,210	112
Operating distribution system	2,501	3,200	(699)
Operating distribution reservoirs	3,472	3,250	222
Groundskeeping on rights of way	6,932	3,570	3,362
Hydraulic tests and flow measurements	1,433	1,575	(142)
Removing and resetting meters	4,632	3,810	822
Services on customers' premises	2,371	2,000	371
Other operating functions	1,642	1,375	267
Subtotal	28,486	23,810	4,676
Maintenance			
Maintaining exposed mains	2,374	1,810	564
Repairing main regulators	1,722	1,620	102
Repairing cast-iron mains	6,240	5,460	780
Repairing asbestos-cement mains	4,136	4,440	(304)
Repairing other mains	2,020	1,760	260
Transferring services to new mains	4,316	2,850	1,466
Repairing copper services	3,520	3,460	60
Repairing other services	3,313	3,260	53
Repairing main gate valves	1,077	920	157
Repairing meter boxes	1,708	1,500	208
Repairing meters in field	6,145	3,620	2,525
Repairing meters in shop	4,692	3,760	932
Repairing hydrants	2,114	1,550	564
Other maintenance functions	3,953	3,200	753
Subtotal	47,330	39,210	8,120
Total	$89,555	$75,360	$14,195

head costs to direct costs for the entire distribution division. The total costs for overhead ($13,739), operation ($28,486), and maintenance ($47,330) will be carried forward to the report prepared for the next higher level of responsibility.

Operating Department Summary

Reference to the organization chart reveals that the third level of responsibility is the operating department. In the report prepared for the vice-president of operations, the total costs for each of the several operating divisions are summarized, to show the total cost for the entire operating department (Table 4). Distribution division totals have been brought forward from the report prepared for that division (Table 3). Totals from reports prepared for other divisions have similarly been brought forward.

The total costs for each division are supported by statements prepared on a strict responsibility basis. Supervisors at each level of responsibility have received statements of costs for which they are responsible and over which they have control, without regard to the subsequent accounting treatment of these costs. Costs have been reported to the departmental level before any accounting allocations have been made. At this level, however, indirect expenses, previously unallocated and controlled in total, are assigned to construction or to expense (operations and maintenance) in order to obtain a tie-in to the top income account. This allocation is shown at the bottom of the report (Table 4). Of the $31,493 total overhead cost, $11,685 was allocated to expense ($5,504 to operations and $6,181 to maintenance), and the balance, $19,808, went to construction and other accounts. Adding the overhead allocation to direct operation and maintenance costs gives the total operation and maintenance costs for the operating department. These totals, $91,142 for operation and $90,615 for maintenance, together with related budget and variation amounts, are carried forward into the next higher level report.

TABLE 4

Operating Department Summary

Breakdown	Operation			Maintenance			Overhead		
	Actual	Budget	Variation	Actual	Budget	Variation	Actual	Budget	Variation
Manager of operations	$ 4,922	$ 4,240	$ 692	$ 3,792	$ 3,630	$ 162	$ 5,612	$ 5,500	$ 112
Water supply division	4,168	4,200	(32)	2,043	1,750	293	1,826	2,000	(174)
Transmission division	11,322	9,090	2,232	14,716	10,220	4,496	4,312	3,620	692
Distribution division	28,486	23,810	4,676	47,330	39,210	8,120	13,739	12,340	1,399
Pumping division	15,714	13,900	1,814	10,042	8,860	1,182	3,012	2,660	352
Purification division	21,026	18,100	2,926	6,511	5,200	1,311	2,992	2,400	592
Subtotal	85,638	73,330	12,308	84,434	68,870	15,564	31,493	28,520	2,973
Overhead allocated to:									
Operation and maintenance	5,504	4,526	978	6,181	4,921	1,260	(11,685)	(10,838)	(847)
Construction and other							(19,808)	(17,682)	(2,126)
Total	$91,142	$77,856	$13,286	$90,615	$73,791	$16,824	$ 0	$ 0	$ 0

Top-Level Reports

The fourth, or top-level, report is the departmental expense summary, prepared for the president and the vice-

TABLE 5

Departmental Expense Summary

Department	Actual	Budget	Variation
Operations			
Finance	$ 44,828	$ 42,750	$ 2,078
Personnel	14,289	12,360	1,929
Operating	91,142	77,856	13,286
Commercial	60,069	56,250	3,819
General	24,849	25,200	(351)
Subtotal	235,177	214,416	20,761
Maintenance			
Operating	90,615	73,791	16,824
Total	$325,792	$288,207	$37,585

presidents. Total expenses for each department, segregated into operation and maintenance, are clearly indicated in this report (Table 5). The amounts of $91,142 for operation and $90,615 for maintenance, which were brought forward from the responsibility statement prepared for the operating department, will be recognized. The amount of $24,849, designated as general, includes expenditures such as directors' fees, registration fees, and the like, which are the collective responsibility of top management and not of any particular department.

This statement gives at a quick glance the total operating expenses by department and shows each department's performance in relation to the budget. The total figures for each department are supported by a series of reports built up in the manner illustrated for the operating department. The number and method of buildup of reports prepared for any given department are dependent upon its organizational structure.

In addition to furnishing a summary of expenses by department, this statement also provides the support for the items "Operations" and "Maintenance" in the top income account, the statement of income and expense (Table 6).

The total amounts for operations and for maintenance are readily identified on this income statement. Under responsibility accounting, these two figures are fully supported by the responsibility statements previously reviewed. It is these reports which management uses in exercising control over the operations of the company.

Organizational Relationship

Figure 2 illustrates the parallel relationship of the organization chart and the reports, and will serve as a basis for a brief review of the buildup of reports from the lowest level of responsibility to the top departmental expense summary. As shown in Fig. 2, controllable expenses were, at the outset, reported in detail for the first district. The total expenditures for the first district were then carried forward into a report for the distribution division supervisor, the next higher level of responsibility. In this report, total expenditures for the first district were combined with totals for the second and third districts and with the expendi-

tures for functions that were a direct responsibility of the division supervisor, to arrive at a grand total of expenditures for the distribution division.

Expenditures for the distribution division were also summarized by function in another statement prepared for the division supervisor, and this statement provided the totals for operation, maintenance, and overhead that were carried forward into the operating department functional summary. On this summary, totals were shown for each division within the operating department, and, at the bottom of the statement, total overhead costs were allocated between operation and maintenance, to arrive at the total operations and maintenance costs for the department. These two totals were then carried forward into the departmental expense summary. In this statement, totals for all departments were listed, to arrive at total amounts for operation and for maintenance, which were carried forward into the top income statement.

The buildup of reports is extremely simple because it follows the organizational lines of the company. In fact, when one understands the organization of the company, one automatically understands how the responsibility reports are built up and, more important, how to use them.

The principal features and advantages of responsibility reporting may be summarized briefly:

TABLE 6

Statement of Income and Expense

Item	Actual	Budget	Variation
Operating revenue			
Water	$681,618	$665,300	$16,318
Other	18,752	20,000	(1,248)
Total operating revenue	$700,370	$685,300	$15,070
Operating expenses			
Operations	$235,177	$214,416	$20,761
Maintenance	90,615	73,791	16,824
Depreciation	175,833	175,833	0
Taxes—federal income	8,600	11,800	(3,200)
Taxes—all other	27,970	28,000	(30)
Other operating expenses	32,625	31,360	1,265
Total operating expenses	$570,820	$535,200	$35,620
Net operating income	$129,550	$150,100	($20,550)
Other income	7,162	7,000	162
Gross income	$136,712	$157,100	($20,388)
Income deductions	73,634	74,584	(950)
Net income	$ 63,078	$ 82,516	($19,438)

1. The cost reports are simple, concise, and easy to understand. The value of any report depends upon the extent to which it is used. A report that can be understood by operating personnel is much more likely to be used by them than a complicated report that can be interpreted only by an accountant.

2. Responsibility for costs is clearly indicated in the reports at each level in the organization.

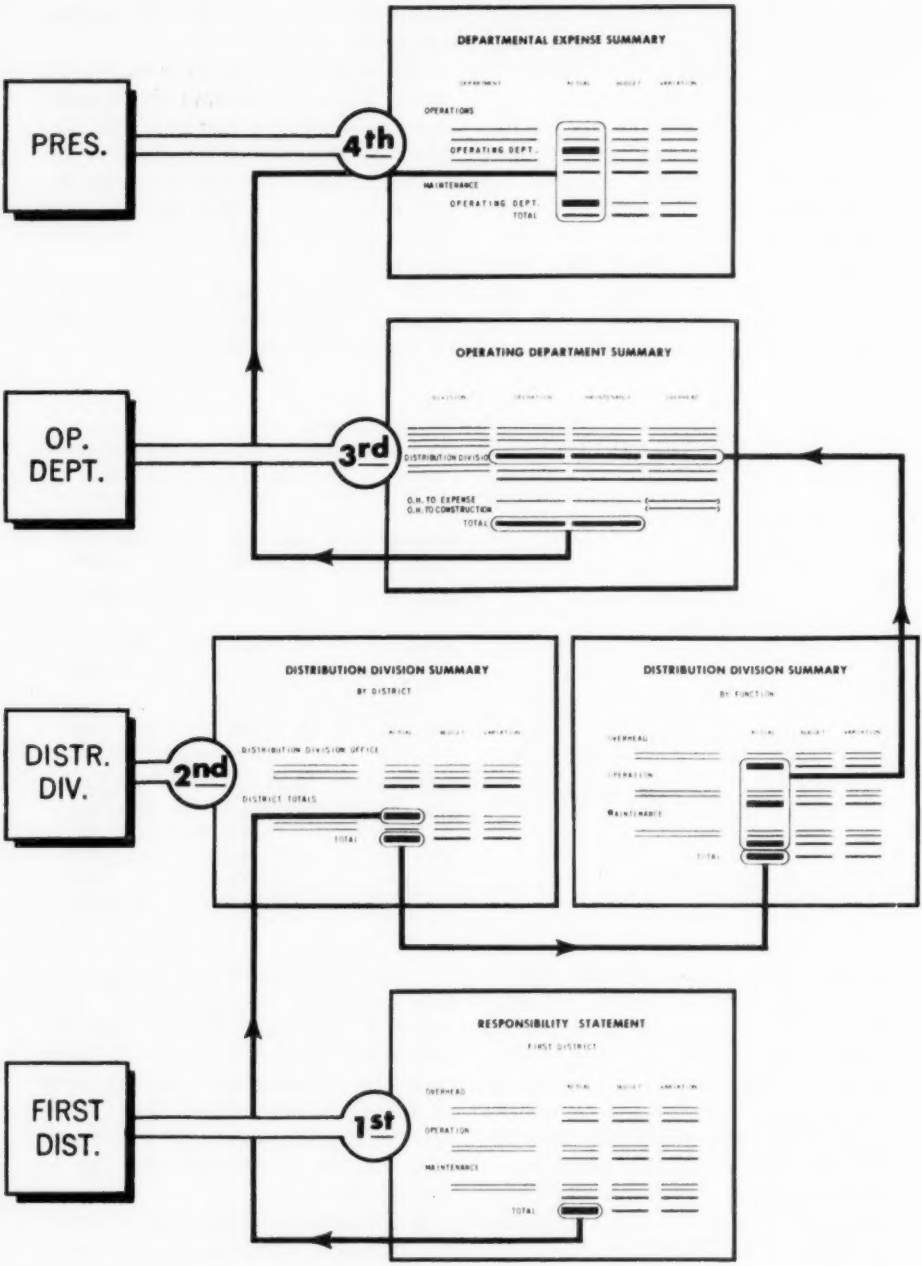

Fig. 2. Relationship of Organization Chart to Reports

3. Responsibility accounting permits effective budgeting and budgetary control by providing for: (a) the identification of individuals responsible for variations from the budget and (b) the reporting and budgeting of costs by natural divisions of work.

Fixing of Responsibility

To illustrate how this system of responsibility accounting meets the first requirement of effective budgetary control—the ability to fix responsibility for budget variations—further reference should be made to Tables 1–6. The facility with which budget variations may be traced quickly from the top income account down to the lowest level of responsibility may be readily demonstrated. Starting with the statement of income and expense (Table 6), a variation of $20,761 in operations and a variation of $16,824 in maintenance will be noted. In order to determine which departments were responsible for these variations, proceed downward to the departmental expense summary (Table 5). In this statement, it will be seen that the operating department is responsible for the entire maintenance variation and for a major portion ($13,286) of the variation in operations. Accordingly, proceed to the operating department summary (Table 4), which shows variations in several divisions. The distribution division, however, is responsible for the largest variations. To determine who was directly responsible, turn to the distribution division summary by district (Table 2). From this report, it is evident that the largest variation occurred in the first district. The responsibility report for the first district (Table 1) indicates that the greatest variations occurred in two functions: "groundskeeping on rights of way" ($2,586) and "repairing meters in fields" ($2,532).

For additional information, reference would next be made to the detail cost ledger. Although not illustrated herein, this ledger would reveal the detail of costs by source (labor, material, purchases, and so on) charged to each function. The next step would be to determine whether the work was justified and whether it had been anticipated when the original budget was prepared.

Budget Preparation

The determination of responsibility for budget variations, together with the provision of information required to track down reasons for variations, is the first requirement of effective budgetary control. A second important requirement is the reporting and budgeting of costs by natural divisions of work. The logical way to prepare any budget, whether for a utility or a commercial enterprise, is first to plan the work to be done and then to estimate the cost of doing it. The work to be done is normally considered in terms of projects that are, in effect, functions or natural divisions of work.

To illustrate how responsibility accounting facilitates budget preparation, the uniform account classification, "operation of distribution lines," may be considered. This classification comprises the following work operations or functions (shown in Table 3): inspecting distribution system, investigating water leaks, operating distribution system, operating distribution reservoirs, groundskeeping on rights of way, and hydraulic tests and flow measurements.

The common-sense method of preparing the budget would be to estimate expenditures by these natural divisions of work, because that is the way the

work is planned. If costs were recorded by the accounts provided in the uniform system, the expenditures for these various functions would appear only as a single total for "operation of distribution lines." It would then be more difficult to establish the budget and impossible to determine where the variations occur, without a great amount of analysis. On the other hand, under a system of responsibility accounting, budgets and accumulated costs are reported according to natural divisions of work, and the pinpointing of variations is a simple operation.

Avenues of Expenditure

Utilities have three main avenues of expenditures—operating expenses, construction, and overhead (indirect expense). The last is eventually assigned to both operating expenses and construction. To have a complete and effective expenditure control, all three of these avenues must be controlled.

In most utilities, construction expenditures are controlled through the medium of work orders. Such control may be inadequate, however, unless those directly responsible for construction expenditures are currently advised both on sums expended and on their relation to approved amounts. Too often the work order system discloses an excess over budget long after the work has been completed and when it is too late to take any corrective action.

The foregoing has illustrated how responsibility accounting provides an effective control over the operating expenses and the overhead (indirect) expenditures. Control over these costs has been established by relating the reporting of costs to the individuals in the organization who are responsible for their control. Overhead expenses have been controlled *before* being allocated to, and subsequently buried in, operating expenses or construction.

The same principles of controlling costs on a responsibility basis should be extended to cover construction expenditures. The general pattern of building up reports that was illustrated in connection with operating expenses can be readily applied to construction expenditures. Such reports for construction should not only provide a comparison between amounts expended and amounts approved but should also set forth the amounts of purchase commitments and the amounts unexpended and not committed. This element of purchase commitments is often overlooked but must be recognized to gain effective control and to provide an accurate tie-in of construction expenditures to the forecast of cash requirements.

With expanded construction programs such as are currently being undertaken by many utilities, a company's cash position and cash requirements assume increased significance. The adequacy of the cash forecast is determined by the adequacy of the budgets on which it is based. Responsibility accounting provides the basis for establishing realistic budgets over all three avenues of expenditure—operating expenses, overhead, and construction.

A Statistical Analysis of Water Works Data for 1950

By Harris F. Seidel, A. Stanford Johnson, and Donald O. Dencker

A contribution to the Journal by Harris F. Seidel, Supt., Sewage Treatment Plant, Ames, Iowa; A. Stanford Johnson, Instructor in Civ. Eng., Univ. of Minnesota, Minneapolis, Minn.; and Donald O. Dencker, San. Engr., Pfeifer & Shultz, Engrs., Minneapolis, Minn.

IN June 1953 the JOURNAL published "A Survey of Operating Data for Water Works in 1950," containing tabulated information on physical plant, production and distribution, financial condition, and rate structures of 416 water utilities serving populations of 10,000 or more (*1*). To present these data in a form more useful to the field, they have been subjected to statistical analysis, the results of which are shown in Tables 1–30, beginning on page 1321. For convenience, a concordance, which lists the items in the June 1953 tabulation by table and column number and shows the relevant table in the present analysis, is given on page 1320. In the course of the analysis, some errors were noted in the June 1953 tables; they are listed on page 1334.

The June 1953 tabulation was based on questionnaires returned by the 416 cities listed therein, which represent approximately 35–40 per cent of all cities in the United States with populations of 10,000 or more in 1950. The total population served by these 416 cities was approximately 50,000,000. Not all of the respondents replied to every question, but the trends indicated in the analysis are believed to be generally valid for the entire group.

The conclusions drawn from this analysis (*see page 1319*) *show unmistakably that rate structures have not kept pace with the rise in construction and operating costs in recent years.*

City Groupings

For the purposes of this analysis, the cities surveyed were divided into six population groups:

Population Group	Population *1,000's*
1	10–25
2	25–50
3	50–100
4	100–250
5	250–500
6	500 and over

For a number of items, it was found that a more definite trend resulted when the cities were classified by volume group, in accordance with annual water production:

Volume Group	Annual Production *mil gal*
1	under 500
2	500–1,000
3	1,000–2,000
4	2,000–4,000
5	4,000–10,000
6	10,000–50,000
7	50,000 and over

Throughout the tables and illustrations, these population and volume groups are referred to by number, as above.

Although volume of production generally increases with the size of city, population is not necessarily an index of production for a specific city, as a comparison of the "minimum" and "maximum" columns in the following table show:

Population of Cities in 1950 Survey, by Volume Groups

Volume Group	No. of Cities	Population—*1,000's*					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	29	10	24	14	12	13	16
2	86	10	37	20	15	19	23
3	92	10	72	31	21	30	38
4	73	15	150	60	44	52	70
5	47	26	330	124	74	111	165
6	51	94	760	344	230	327	457
7	8	802	4,138	1,750	1,030	1,530	1,980
U.S.	386	10	4,138	121	20	38	95

In analyzing production, sales, and rates, it also proved worth while to classify the cities by geographic location, in accordance with the following regional groupings:

1. *New England*—Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
2. *Middle Atlantic* *—Delaware, Maryland, New Jersey, New York, Pennsylvania
3. *North East Central*—Illinois, Indiana, Michigan, Ohio, West Virginia
4. *North West Central*—Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota, Wisconsin
5. *South*—Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia
6. *Mountain*—Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming
7. *Pacific Coast*—California, Hawaii, Oregon, Washington.

* Washington, D.C., is included in this group.

Statistical Terminology

The few statistical terms which are employed in this analysis may be briefly defined:

Mean—the arithmetic average, obtained by dividing the sum of the data for all cities by the number of cities concerned.

Median—that individual value of a series which is greater than half the values in the series and less than the other half; unlike the mean, the median is only slightly affected by unusually high or low values in a series.

Quartiles—the three values that divide a series into four equal parts; the "first quartile" (1st Q.) is that value which is greater than one-fourth of the values in the series and less than three-fourths; the "third quartile" (3rd Q.) is greater than three-fourths of the values and less than one-fourth; the

"second quartile" is, of course, the median.

Most of the tables in this analysis show minimum, maximum, mean, first quartile, median, and third quartile values. On the bar graphs, the minimum value is the lower end of the bar and the maximum the upper end; the black portion of the bar shows the range between the first and third quartiles; the mean is indicated by the apex of a black triangle and the median by the apex of a white triangle; mean and median values for the entire United States (that is, for all cities furnishing data on the item under study) are shown by large black or white triangles, respectively.

Scope of Study

The analytical tables have been grouped in accordance with the subjects covered, in this general sequence: production and sales, distribution system, source of supply, treatment, revenue and expense, book value, and rate structure. In addition, a comparison of mean values of various items is shown for public and privately owned utilities.

Also for purposes of comparison, values obtained from a previous survey (*2*) of 1945 operating data have been included in the tables or are mentioned in the brief comments below. These values were either calculated by the present authors or taken directly from an analysis of the 1945 data made by Schroepfer and others (*3*). The 1945 tabulation was arranged in much the same manner as the 1950 one, with a few exceptions—for example, the 1950 breakdown of expenses included a "miscellaneous" item, while the 1945 breakdown did not. Of the 416 cities in the 1950 survey, 296 were also represented in 1945. Consequently, it is felt that a fair comparison of the results of the two surveys is possible. Table 30 is a summary of values for 1945 and 1950.

Production and Sales

Production. For the 387 cities reporting (Table 1), water production in 1950 varied from a minimum of 51 to a maximum of 446 gpcd, with a mean of 138 and a median of 122 gpcd. From 1945 to 1950 the demand for water increased sharply, both by virtue of rising per capita use and because of an increase in population served. The population increase is difficult to evaluate but is conservatively judged to be 8–10 per cent. Over the 5-year period, mean and median per capita production values increased 10 and 11 per cent, respectively. The increase in water use was fairly consistent in all population and volume groups.

As in 1945, per capita production in 1950 was highest in the Mountain States, with the Pacific Coast second (Fig. 1). New England was again the lowest, with the South next. It may also be noted that the range of per capita production was smaller in the South than in any other part of the country and that only in this region did the median value exceed the mean. A comparison by geographic regions for only those cities reporting in both the 1945 and 1950 surveys showed slight (2 per cent) increases in per capita production for the Mountain and Middle Atlantic states; "normal" (8–14 per cent) increases for the New England, Central, and Facific states; and a peak increase of 17 per cent for the South. Further, a comparison for only Gulf Coast states showed an increase of 27 per cent, pointing up the trend toward greater industrialization

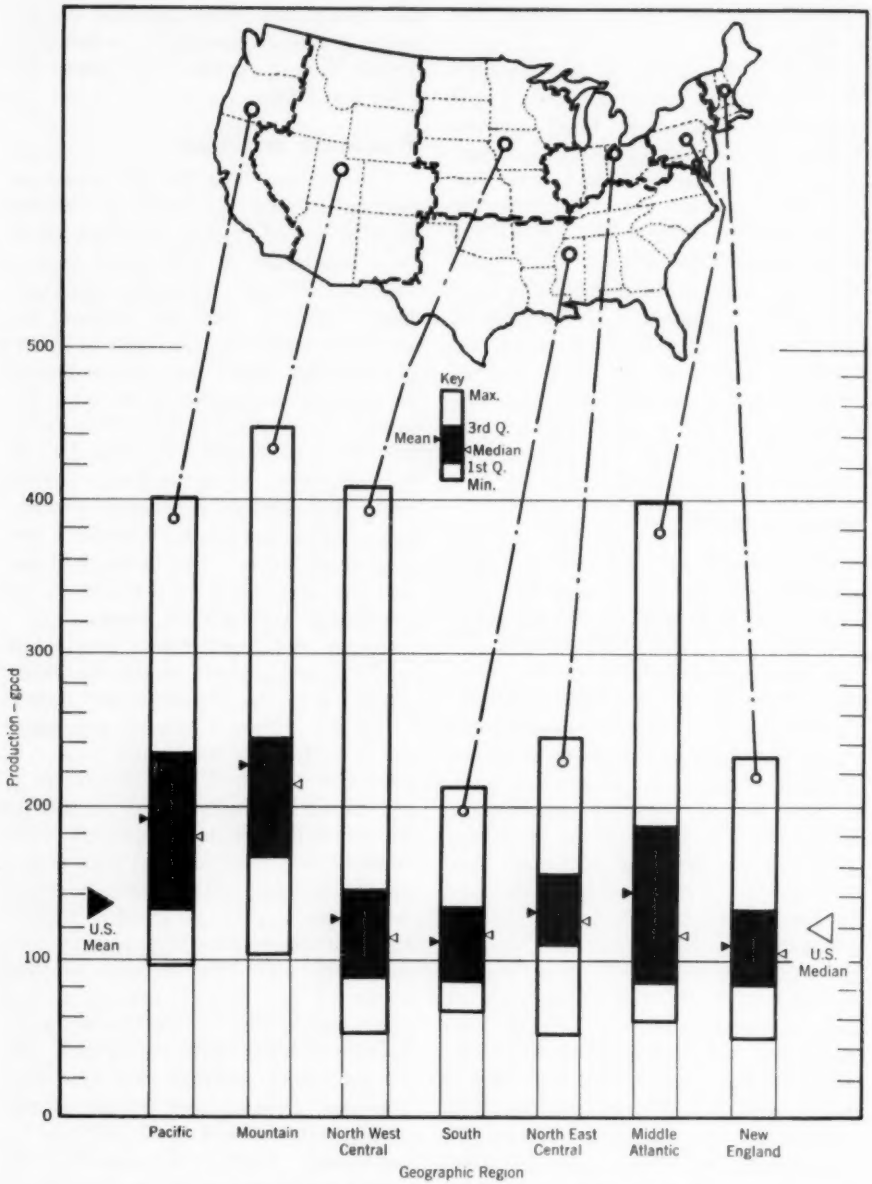

Fig. 1. Per Capita Production, by Geographic Regions

Mean per capita production in 1950 was highest in the Mountain States and lowest in New England.

and general improvement of economic status in this area.

An analysis by population groups (Table 2 and Fig. 2) confirms the conclusion drawn from the 1945 study that the size of city has little effect on per capita production, except in cities of 500,000 or more (Population Group 6). Only in that group was there a significant variation; mean and median values for Group 6 were 25 and 55 per cent, respectively, above mean and median values for all cities reporting.

When per capita production is analyzed by volume groups (Table 3), a consistent trend is evident. As the *total* production increases, the *per capita* production also rises, to the extent that mean and median per capita values for Volume Group 7 are more than double those for Volume Group 1. The explanation may be that, as in other industries, the large water utility operates at relatively low unit costs which permit it to offer its product at a lower rate and thereby increase its sales.

Table 4, which relates per capita production to rate structure, tends to bear out this view. For each of the four rate steps reported, the group of cities with the lowest rates showed the largest per capita production. It should be pointed out, however, that this observation is based on a nation-wide survey and that local situations may sometimes run counter to this trend.

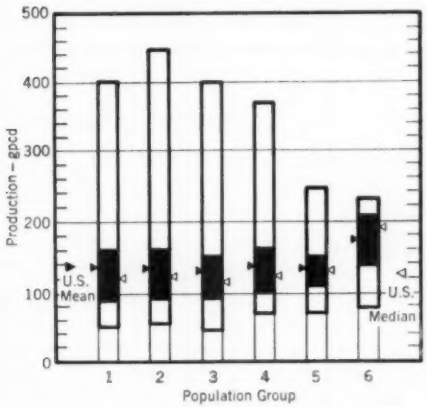

Fig. 2. Per Capita Production, by Population Groups

Except in the largest population group (Group 6), the size of city appears to have little effect on per capita production.

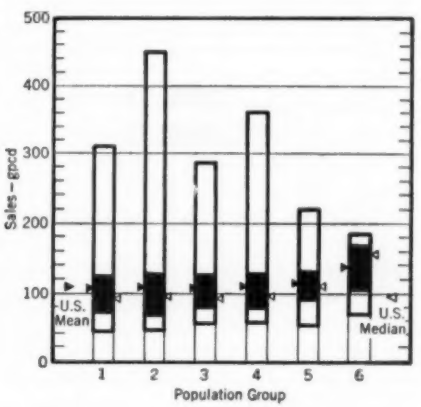

Fig. 3. Per Capita Sales, by Population Groups

Sales trends closely followed production trends, as a comparison with Fig. 2 will indicate.

Sales. In 1950 the mean sales figure for the 344 cities reporting was 110 gpcd and the median value was 98 gpcd—a rise of 11 and 10 per cent, respectively, since 1945. As might be expected, sales figures (Tables 5–7 and Fig. 3 and 4) exhibited trends similar to those found for production. Consequently, the data on percentage of production sold showed no signifi-

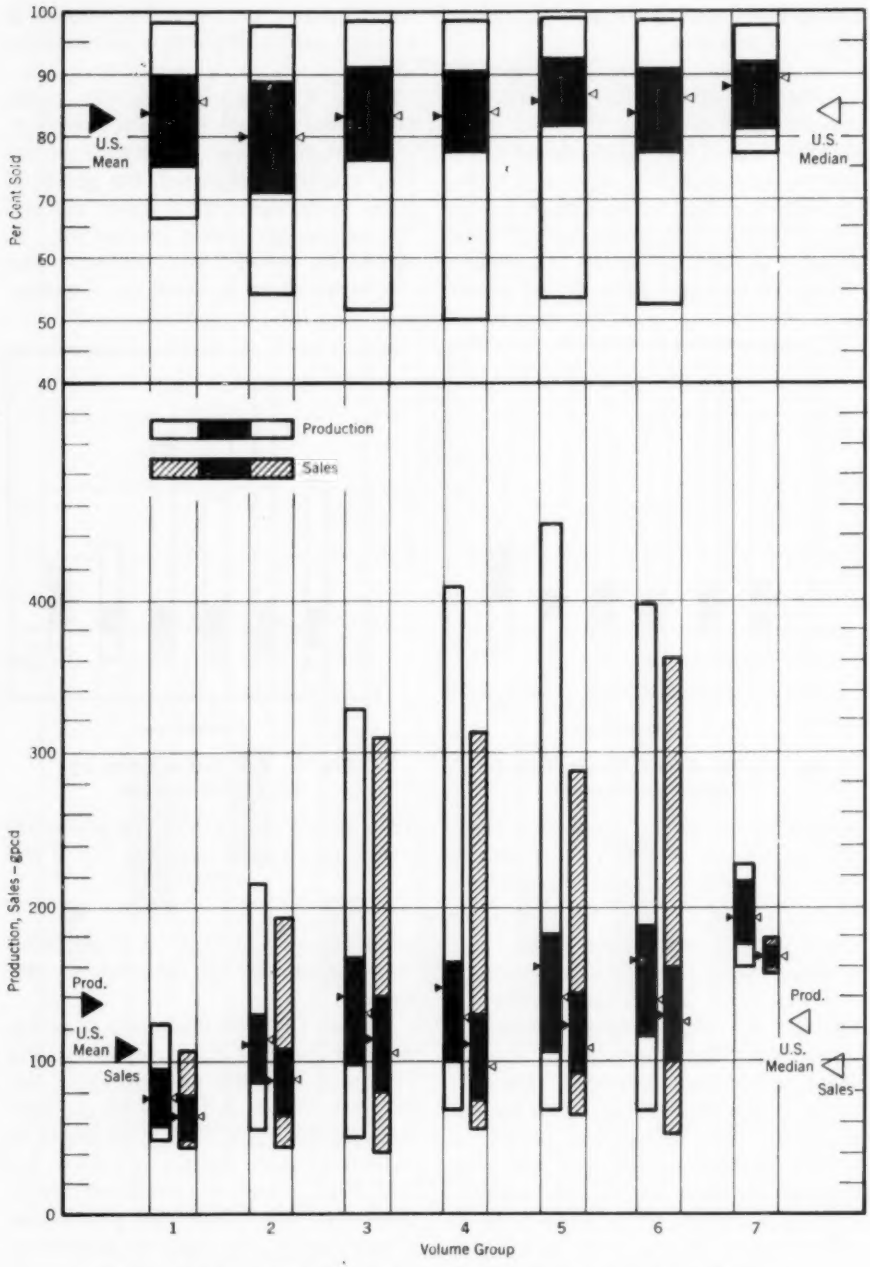

Fig. 4. Production, Sales, and Percentage Sold, by Volume Groups

cant trend when analyzed by either population groups (Table 8), volume groups, or geographic regions.

Percentage production sold. For the 332 cities reporting both production and sales, the mean percentage sold was 83 and the median was 84. In contrast, a direct comparison of the entire group furnishing production data (387 cities) and the entire group giving sales figures (344 cities) yielded a value of 80 per cent sold. This may indicate that water losses were above normal for some of the utilities not reporting both production and sales.

Distribution System

Data on distribution mains, valves, hydrants, and storage were analyzed by population groups. In the 1950 tabulation, the reported lengths of distribution mains of various sizes were converted to an equivalent mileage of 8-in. main. Table 9 presents an analysis of miles of 8-in. equivalent main per 1,000 population. Data on valves and hydrants per mile of 8-in. equivalent main are summarized in Table 10.

For the purposes of this study, total distribution system storage was converted into percentage of average daily production. The analysis of the resulting values (Table 11) is a good example of the pitfalls inherent in statistical work. The mean value for 333 cities was 160 per cent—more than 1½ days' storage at average demand. The mean, however, was distorted by a few extreme values; the median value was 100 per cent, the quartile points were 50 and 200 per cent; and the most frequent, or typical, value was roughly 80 per cent—just half the mean. For the data on storage, no noteworthy relationship to population or volume groups was observed.

Source of Supply

Of 414 cities for which data were available (Table 12), 53 per cent used surface supplies exclusively. Ground water sources were, of course, more important in the smaller cities than in the larger. Although 28 per cent of the cities used ground water exclusively, they accounted for only 12 per cent of the total volume produced. Approximately 5 per cent of the 414 cities purchased all their water, while 14 per cent employed a combination of types of supply.

Treatment

In the 1950 survey, water treatment was tabulated in five categories: filtration, softening, corrosion control, other (exluding chlorination), and none (excluding chlorination). Of the 416 cities listed, 111 reported no treatment and 120 filtration only. The remaining 185 reported various other types and combinations. Of these cities, 114 used filtration in combination with other treatment. Softening, alone or in combination, was reported by 73 cities.

For the purposes of the present study, three treatment classes were adopted: "minor," including no treatment and treatment other than filtration, softening, or corrosion control; "filtration," including that type only; and "advanced," including all other types and combinations. Of the 161 cities with minor treatment, 70 per cent used either purchased or ground water; more than 80 per cent of the 120 cities in the filtration class employed surface supplies; and approximately 67 per cent of the 135 cities with advanced treatment also used surface supplies. Further study of this last class brought out no significant cost difference by source.

Table 13 shows the relationship between the class of treatment on the one hand and revenue, expense, net income, and rates on the other. In every volume group—except Group 7 (the largest producers), which contained too few cases for the analysis to be valid—the cities with advanced treatment had the greatest operating and maintenance costs and the most revenue per million gallons, as well as the highest rates. There appeared to be no close correlation, however, between treatment class and net income.

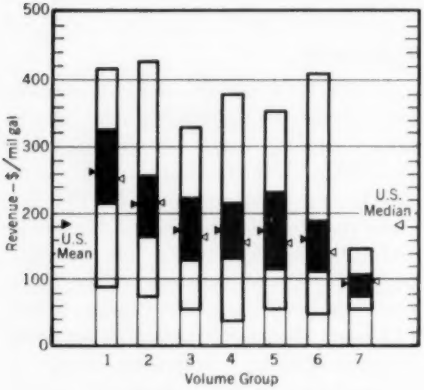

Fig. 5. Revenue on Quantity Basis, by Volume Groups

There was almost a 3 : 1 variation between the smallest and largest groups.

Revenue and Expense

The 1950 questionnaire provided for a fairly complete financial report; the survey yielded a mass of data on source of revenue, cost distribution, income, book value, debt, and their relationships. Analysis of these data was handicapped somewhat by incomplete returns and by lack of agreement on the exact meaning of such terms as income, debt, and depreciation.

Total revenue. Total revenue from all sources was analyzed by volume groups (Tables 14 and 15) and by population groups (Table 16). Mean per capita revenue for 403 cities was $7.86, with a median value of $7.87—an increase of 29 and 39 per cent, respectively, over 1945. No significant trend by size of city or production volume was apparent. On the other hand, total revenue in dollars per million gallons showed almost a 3 : 1 variation from the smallest to the largest volume group (Fig. 5). Mean and median values on a volume basis were $188 and $183, respectively, per million gallons produced—a 24 per cent increase since 1945.

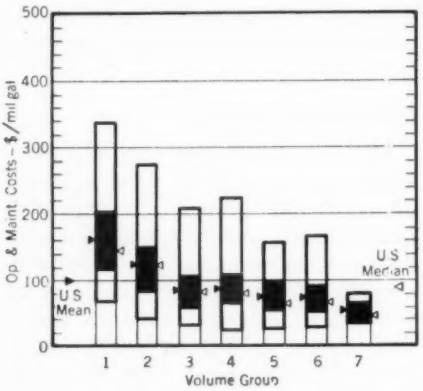

Fig. 6. Operating Costs on Quantity Basis, by Volume Groups

These cost figures include operation, maintenance, and wages. As for revenue, a 3 : 1 variation may be observed between Groups 1 and 7.

Revenue sources. Data on sources of revenue, available for less than half of the cities surveyed, indicated that 90 per cent of total revenue came from sales to residential, commercial, and industrial customers (Table 17). The remaining 10 per cent was accounted

for by municipal sales, fire service, and miscellaneous income. It should be noted that customer classes are defined in various ways; as reported, however, the proportion of revenue from commercial service was shown to increase in larger cities, while that from industrial service decreased; the proportion of residential service revenue appeared to be essentially unaffected by the size of city.

Operation and maintenance expense. Operation and maintenance costs, including wages, were also analyzed by volume groups (Tables 18 and 19) and by population groups (Table 20). On a per capita basis, the mean cost value was $4.35—higher by 44 per cent than in 1945. Per capita cost tended to decline slightly with an increase in size of city or production volume.

As with revenue, operation and maintenance costs on a volume basis showed a 3:1 variation from the smallest to the largest volume group (Fig. 6). The mean cost was $98 per million gallons produced, compared with $75 in 1945.

A breakdown of total expense into the various cost elements, by percentages, is given in Table 21 for 230 cities. For 93 cities the available data made it possible to distribute wages between operation and maintenance, enabling the cost ratio of these two items to be calculated. Although the terms "operation" and "maintenance" have different meanings in different cities, surprisingly little deviation from a 3:1 ratio was found.

Depreciation. The percentage of expense represented by depreciation appeared to increase with production volume. In terms of dollars per million gallons, however, it was fairly constant for all volume groups.

Taxes. The tax figures tabulated are highly deceptive in that fully 70 per cent of the tax cost shown was paid by private water utilities, representing little more than a tenth of the cities reporting. This situation is shown more clearly in a later comparison of private with public systems (Table 29).

Total expense. On the average, operating costs (operation, maintenance, and wages), depreciation, taxes, and miscellaneous costs contributed $98, $17, $8, and $5, respectively, to a mean total expense of $128 per million gallons in 1950—an increase of more than 39 per cent over 1945.

Income. Table 22 is an analysis of the difference between total revenue and total expense, by volume groups. The mean value for this difference was $60 per million gallons (almost the same amount as in 1945), with little deviation except in the largest production group. Table 23 is a similar analysis, with bond interest included in expense. The mean difference then became $46 per million gallons. A number of utilities were shown to be operating at a loss, but it should be observed that depreciation charges were usually responsible and that depreciation accounting practices are far from uniform.

Operating ratio. Table 24 presents data on the operating ratio (the relation of operating and maintenance cost, including wages, to revenue). The mean value (378 cities) was 1:2.1, a small decrease from the 1945 mean of 1:2.2. There was only slight variation with size of city, but the largest population group showed the lowest mean value.

Book value. The mean per capita book value in 1950 (375 cities) was

$68, an increase of approximately 19 per cent over 1945 (Tables 25 and 26). As expected, the larger producers generally showed higher values than the smaller ones.

Rate Structure

Monthly rates. Monthly rates in dollars per 1,000, 10,000, 100,000, and 1,000,000 cu ft were compared for the various volume groups (Table 27 and Fig. 7). The mean rates for these quantities were, respectively, $2.30, $17.20, $118, and $935. The rates charged by the smallest producers were roughly double those charged by the largest, while those for Volume Group 4 (2–4 bil gal per year) most nearly approximated the overall mean values. The analysis of rates by population groups showed no significant trend.

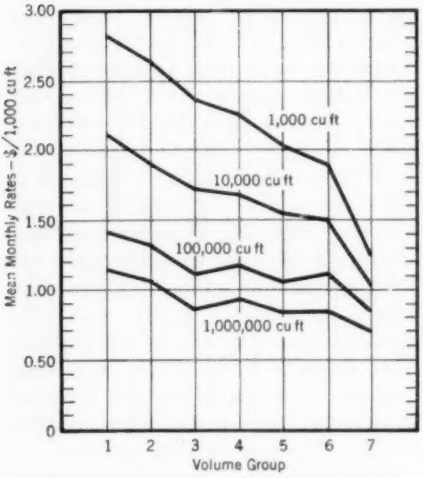

Fig. 7. Mean Monthly Rates, by Volume Groups

The smallest producers charged roughly twice as much as the largest.

Since 1945 the mean rates have increased approximately 20 per cent, except for the 1,000,000-cu ft step, where the rise was only 15 per cent. It should be mentioned, however, that the 1950 rate tabulation probably included service charges in more instances than the 1945 survey did, so that the increases may not actually have been as great as they seem.

Table 28 gives the 10,000-cu ft rates for the various geographic regions. The Mountain States showed the lowest rate. It will be recalled that this

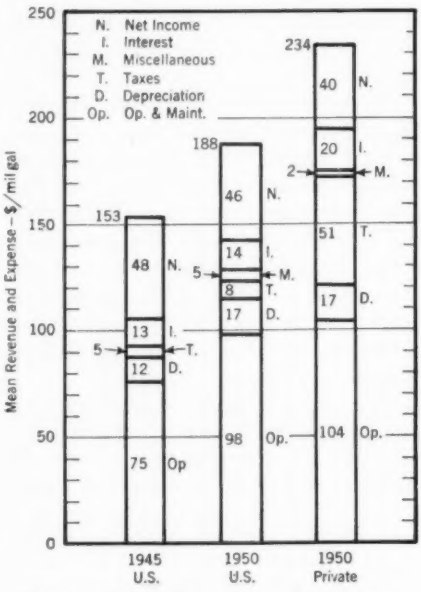

Fig. 8. Mean Revenue and Expense, 1945 and 1950

The top of the bars represents the total revenue, in dollars per million gallons produced. The bars are divided into sections to show the distribution of costs, also in dollars per million gallons. The high proportion of taxes paid by private utilities is obvious.

region had the highest per capita production. Further study indicated that this inverse relationship between rates and production was found in every region.

Rate features. Minimum charges varied from \$0.15 to \$4.25 per month, the mean (339 cities) being \$1.00. This figure was also the median and most frequent value. The quantity allowed for the minimum charge ranged from 33 to 2,500 cu ft, with the mean (316 cities) 485 cu ft. The median allowance was 400 cu ft. Penalty charges on overdue bills were reported by 165 cities; 64 cities gave a discount; and 7 had both. Flat rates, in at least the three final steps, were reported by 20 cities, while 15 others came very close to having a flat-rate schedule.

Privately Owned Utilities

Of the 416 cities tabulated in the 1950 survey, 48 were served by privately owned water utilities. In general, the data submitted by a private utility were likely to be more detailed than those from a typical public utility. The comparison of privately and publicly owned utilities was aided by a reasonably even distribution of private systems throughout the first six volume groups. It should be noted that mean values for private utilities are compared with mean values for public utilities alone, in Table 29, and with mean values for both types combined, in Fig. 8.

Production and rates. Per capita production by private utilities was 11 per cent below that for public systems, and sales were also 11 per cent less, with the result that the percentage-sold figures were identical.

Private utilities reported higher rate schedules, varying in degree from 29 per cent at the first rate step to 4 per cent at the final step. In addition, the minimum charge was 10 per cent higher, and 22 per cent less water was allowed for it.

Financial data. With their higher rates, private utilities were deriving 27 per cent more revenue than the public utilities. This additional revenue of \$50 per million gallons, however, was almost completely consumed by taxes which public utilities did not pay. Consequently, private and public utilities showed identical revenue-less-expense figures. After paying interest on roughly 1½ times as much debt, the private utilities as a group had 15 per cent less net income than the public water works.

Conclusions

The preceding discussion of the 1950 analysis has referred to 1945 data for comparison. Some of these comparative statistics are summarized in Table 30 and Fig 8. Although there is undoubtedly a large uncertainty factor present in such a comparison, it seems worth while to outline some of the implications contained in it.

Since 1945, revenue has increased \$36 per million gallons, a rise of 24 per cent. Meanwhile total expense has increased \$37 per million gallons, or 40 per cent. From a casual inspection of Table 30, it appears that operation and maintenance costs have risen only 32 per cent. Miscellaneous costs, however, were not reported separately for 1945; if they had been lumped with operation and maintenance costs in the 1950 data, the increase in the latter would then have been 40 per

Concordance of Survey and Analysis Tables

Survey (June 1953 Journal)	Subject	Analysis (Dec. 1953 Journal)
Table 1, Column		Table No.
9	Source of supply	12
10	Type of treatment	13*
13	Per capita book value	25, 26
15	Per capita revenue	14, 16
17	Per capita op. and maint.	18, 20
18	Operating ratio	24
Table 2, Column		
4	Per cent production sold	8
5	Per capita production	1–3
6	Per capita sales	5–7
10	Distribution mains	9
13	Valves per mile of main	10
15	Hydrants per mile of main	10
16, 17	Distribution storage	11
Table 3, Column		
2–9	Revenue	14–17
11–13	Op., maint., and wages	18–20
11–17	Expenses	21
19	Revenue less expense	22
19, 20	Revenue less expense and bond interest	23
Table 4, Column		
2–5	Monthly rates	4†, 27, 28
—	Comparison of public and private utilities	29
—	Comparison of 1945 and 1950 data	30

* Relates type of treatment to revenue, expense, and rates.
† Relates rate structure to production.

cent, the same as for total expense. The net effect of these revenue and cost increases has been to reduce income by \$1–\$2 per million gallons (Fig. 8).

On a per capita basis, revenue has increased 34 per cent and operation and maintenance cost 45 per cent. When allowance is made for the increased per capita use of water, these values are in close agreement with the revenue and cost increases on a volume basis.

It is evident that rate structures have not kept pace with the times. For example, if the income on a volume basis were to keep step with a reported (*4*) cost index rise on the order of 6:10, this would have required a revenue increase of at least \$67 instead of the increase of \$36 per million gallons actually obtained. In those terms, admittedly severe, actual rate increases were only 54 per cent sufficient.

Taking into consideration the increase in water consumption as well as in population since 1945, additional income of only \$18 per million gallons would have been required in 1950. Even in these more liberal terms, the actual rate increases were only 67 per cent sufficient. Such figures graphically illustrate the financial problem facing the water works industry today.

References

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3. SCHROEPFER, G. J.; JOHNSON, A. S.; SEIDEL, H. F.; & AL-HAKIM, M. B. A Statistical Analysis of Water Works Data for 1945. *Jour. AWWA*, **40**:1067 (Oct. 1948).
4. FICK, H. H. Cost Indexes for Water Works Property. *Jour. AWWA*, **45**:779 (Aug. 1953).

TABLE 1

Production, by Geographic Regions

Region	No. of Cities	Production—*gpcd*					
		Min.	Max.	Mean	1st Q.‡	Median	3rd Q.§
New England	42	51	234	111	85	106	135
Middle Atlantic	66	61	399	145	87	118	189
South	63	67	214	115	86	118	135
N. East Central	78	52	244	132	111	127	157
N. West Central	82	53	409	127	91	117	144
Mountain	12	102	446	226	(166)‖	215	(242)‖
Pacific Coast	44	98	401	189	135	179	231
U.S.*	387	51	446	138	95	122	160
U.S. (1945)†	398	34	546	125	85	110	145

* Comprises all cities in above groups.
† Schroepfer data (*3*).
‡ First quartile.
§ Third quartile.
‖ Sample too small for statistical validity.

TABLE 2

Production, by Population Groups

Pop. Group	No. of Cities	Production—*gpcd*					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	135	51	401	137	90	121	160
2	99	57	446	137	92	122	160
3	62	53	399	131	93	117	151
4	44	70	371	138	100	121	160
5	30	69	244	135	109	130	151
6	17	78	230	172	139	189	206
U.S.	387	51	446	138	95	122	160
U.S. (1945)	398	34	546	125	85	110	145

TABLE 3

Production, by Volume Groups

Volume Group	No. of Cities	Production—*gpcd*					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	29	51	122	78	60	78	94
2	86	57	216	111	88	113	129
3	91	53	334	140	99	129	165
4	74	70	409	146	100	128	165
5	47	69	446	159	107	140	181
6	51	69	399	166	119	139	189
7	8	161	230	193	(177)	192	(219)
U.S.	386	51	446	138	95	122	160

TABLE 4

Rate Structure and Production

Rate	No. of Cities	Production—*gpcd*					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
$/1,000 cu ft							
less than 1.20	29	101	409	195	142	181	228
1.20–1.69	72	58	401	170	118	149	189
1.70–2.19	84	69	446	134	100	120	158
2.20–2.69	73	51	399	133	92	120	154
2.70–3.19	64	52	248	108	81	100	127
3.20–3.99	34	58	254	109	80	98	123
4.00 or more	20	53	214	121	89	128	142
$/10,000 cu ft							
less than 10.00	50	101	409	191	139	178	230
10.00–13.99	80	73	401	161	113	142	182
14.00–17.99	92	58	446	138	98	126	160
18.00–21.99	80	58	260	108	81	99	125
22.00–25.99	31	51	197	116	87	116	139
26.00–29.99	25	52	254	116	79	115	135
30.00 or more	18	53	214	99	62	90	129
$/100,000 cu ft							
less than 60.00	26	86	382	178	120	158	204
60.00– 89.99	91	72	446	170	118	145	208
90.00–119.99	101	65	399	141	106	127	162
120.00–149.99	74	52	248	114	81	103	131
150.00–179.99	41	58	260	114	85	100	133
180.00–209.99	24	57	254	116	79	115	133
210.00 or more	19	51	165	101	65	94	127
$/1,000,000 cu ft							
less than 500.00	43	84	446	193	122	161	231
500.00– 699.99	70	73	409	164	118	144	188
700.00– 899.99	99	65	365	136	102	123	156
900.00–1,099.99	58	58	260	126	85	120	160
1,100.00–1,499.99	58	52	248	115	88	106	129
1,500.00–1,899.99	29	53	254	100	70	87	120
1,900.00 or more	15	51	165	97	70	92	117

TABLE 5

Sales, by Geographic Regions

Region	No. of Cities	Sales—*gpcd*					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
New England	31	43	219	98	69	87	120
Middle Atlantic	52	54	287	111	68	87	155
South	59	51	185	94	71	87	114
N. East Central	75	44	227	106	84	99	131
N. West Central	81	41	312	105	72	94	125
Mountain	11	101	451	186	(127)	163	(199)
Pacific Coast	35	81	362	145	110	136	171
U.S.	344	41	451	110	76	98	130

TABLE 6

Sales, by Population Groups

Pop. Group	No. of Cities	Sales—*gpcd*					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	117	43	312	107	73	94	125
2	85	44	451	109	69	97	130
3	57	57	287	106	80	93	126
4	39	58	362	111	80	97	128
5	29	54	220	118	92	111	132
6	17	68	182	138	105	158	170
U.S.	344	41	451	110	76	98	130
U.S. (1945)	344	28	430	99	65	89	116

TABLE 7

Sales, by Volume Groups

Volume Group	No. of Cities	Sales—*gpcd*					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	26	43	107	65	50	65	78
2	75	44	194	89	64	88	106
3	78	41	310	115	81	103	138
4	62	57	312	110	76	97	128
5	40	65	288	122	94	106	142
6	45	54	362	134	100	122	159
7	6	158	180	168	(160)	168	(175)
U.S.	332	41	362	108	74	98	128

TABLE 8

Percentage of Production Sold, by Population Groups

Pop. Group	No. of Cities	Production Sold—*per cent*					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	111	54.7	98.3	81	73	82	90
2	83	50.6	99.0	84	77	84	90
3	56	53.8	99.4	82	77	83	90
4	38	53.0	99.4	81	80	85	91
5	29	73.2	99.3	87	83	86	91
6	15	54.7	98.3	83	79	85	92
U.S.	332	50.6	99.4	83	77	84	90
U.S. (1945)	327	31.8	99.9	81	75	83	90

TABLE 9

Distribution Main Mileage, by Population Groups

Pop. Group	No. of Cities	Miles of 8-in. Equivalent Main per 1,000 Pop.					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	129	0.9	5.9	2.5	1.9	2.4	3.0
2	102	0.7	5.4	2.4	2.0	2.3	2.7
3	61	0.5	5.8	2.2	1.8	2.2	2.6
4	46	0.8	4.2	2.2	1.7	2.3	2.6
5	30	1.2	3.4	2.3	1.9	2.3	2.8
6	18	1.0	3.2	1.9	1.5	1.9	2.3
U.S.	386	0.5	5.9	2.4	1.9	2.3	2.7
U.S. (1945)*	418	0.2	8.4	2.7	2.0	2.5	3.1

* Based on actual mileage of all sizes of mains.

TABLE 10

Hydrants and Valves per Mile of 8-in. Equivalent Main

Item	No. of Cities	No. per Mile					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
Hydrants	379	1.5	27.5	7.7	5.7	7.5	9.0
Valves	329	1.6	55.7	15.1	10.9	13.8	18.3

TABLE 11—*Distribution Storage, by Population Groups*

Pop. Group	No. of Cities	Storage—*per cent of avg daily production*					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	111	4	1,590	180	55	115	215
2	87	3	1,900	160	55	100	220
3	55	4	1,225	160	60	105	185
4	41	2	1,100	150	45	95	195
5	26	6	375	95	30	65	130
6	13	2	480	180	45	120	300
U.S.	333	2	1,900	160	50	100	210

TABLE 12—*Source of Supply, by Population Groups*

Pop. Group	No. of Cities	Source of Supply*					
		S	S, G	G	P	G, P	S, P
		No. of Cities					
1	146	74	13	52	6	0	1
2	109	55	17	28	6	3	0
3	63	27	6	23	5	2	0
4	47	27	7	8	4	0	1
5	30	22	4	4	0	0	0
6	19	14	2	2	1	0	0
U.S. (*Total*)	414	219	49	117	22	5	2
Per cent of total	100	53	12	28	5	1	0.5
Volume produced—*per cent*		62	23	12	2	0.4	0.2

* Key: S—surface water; G—ground water; P—purchased water.

TABLE 13—*Relation of Treatment Classes to Revenue, Expense, and Rates**

1	2	3	4	5	6	7	8	9	10
Volume Group	Treatment Class†	No. of Cities‡		Revenue *$/mil gal*	Op. & Maint. Cost *$/mil gal*	Revenue Less Expense *$/mil gal*		Monthly Rates	
		Col. 5–8	Col. 9, 10			(a)§	(b)§	*$/1,000 cu ft*	*$/10,000 cu ft*
1	M	15	12	256	135	57	50	2.64	19.90
	F	4	4	182	124	36	33	2.13	15.30
	A	9	10	323	190	78	64	3.31	24.70
2	M	31	30	184	105	54	47	2.36	17.30
	F	23	24	209	111	70	53	2.69	17.45
	A	27	31	246	149	50	39	2.85	21.90

* Columns 5–10 show mean values. † M—minor; F—filtration; A—advanced.
‡ Numbers in left column apply to items in Columns 5–8; numbers in right column, to items in Columns 9 and 10. § In (b) bond interest is included as an expense; in (a) bond interest is omitted.

TABLE 13 (*contd.*)—*Relation of Treatment Classes to Revenue, Expense, and Rates**

1	2	3	4	5	6	7	8	9	10
Volume Group	Treatment Class†	No. of Cities‡		Revenue *$/mil gal*	Op. & Maint. Cost *$/mil gal*	Revenue Less Expense *$/mil gal*		Monthly Rates	
		Col. 5–8	Col. 9, 10			(a)§	(b)§	*$/1,000 cu ft*	*$/10,000 cu ft*
3	M	32	34	162	78	56	49	1.99	14.55
	F	23	25	184	85	68	49	2.40	16.75
	A	28	31	194	103	61	46	2.72	20.40
4	M	21	25	159	71	60	50	1.73	14.60
	F	25	27	171	87	58	34	2.36	17.05
	A	19	22	200	114	58	41	2.70	19.65
5	M	24	25	151	65	58	49	1.85	12.95
	F	6	5	149	82	54	40	1.86	16.60
	A	16	16	224	96	79	55	2.33	19.30
6	M	14	15	137	68	44	35	1.71	12.70
	F	16	19	160	67	64	48	1.76	14.80
	A	15	17	183	89	65	45	2.18	17.60
7	M	1	1	(146)	(80)	(35)	(19)	(1.48)	(14.06)
	F	5	6	89	48	32	21	1.25	10.30
	A	1	1	(77)	(48)	(29)	(21)	(0.97)	(5.66)
U.S.		355	380	188	98	60	46	2.30	17.20

* Columns 5–10 show mean values. † M—minor; F—filtration; A—advanced.
‡ Numbers in left column apply to items in Columns 5–8; numbers in right column, to items in Columns 9 and 10. § In (b) bond interest is included as an expense; in (a) bond interest is omitted.

TABLE 14—*Per Capita Revenue, by Volume Groups*

Volume Group	No. of Cities	Per Capita Revenue—$					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	29	3.33	13.45	6.84	5.81	7.38	8.88
2	86	2.41	15.05	7.77	6.42	7.75	9.71
3	89	4.27	15.45	8.22	6.60	8.06	10.35
4	69	4.63	15.02	8.01	6.35	7.84	9.58
5	46	3.71	16.44	8.29	6.88	8.75	10.47
6	50	4.95	18.89	7.66	6.38	7.42	9.46
7	8	4.14	10.04	6.63	(5.05)	6.68	(7.69)
U.S.	377	2.41	18.89	7.86	6.37	7.87	9.87

TABLE 15—*Revenue per Million Gallons Produced, by Volume Groups*

Volume Group	No. of Cities	Revenue—$/mil gal					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	28	90	417	267	218	251	328
2	81	75	428	212	166	219	258
3	83	56	330	179	130	168	224
4	65	40	380	176	132	158	217
5	46	56	354	176	118	159	232
6	45	49	408	161	113	143	190
7	7	55	146	95	(77)	99	(107)
U.S.	355	40	428	188	133	183	240
U.S. (1945)*	388	28	575	153	108	147	186

* Authors' calculations.

TABLE 16—*Revenue, by Population Groups*

Pop. Group	Revenue—$/capita			Revenue—$/mil gal		
	No. of Cities	Mean	Median	No. of Cities	Mean	Median
1	144	8.11	7.99	124	198	197
2	104	8.03	8.63	93	197	196
3	62	7.63	7.88	54	185	170
4	46	7.63	7.88	41	182	163
5	28	9.40	7.17	27	192	170
6	19	6.25	6.08	15	124	105
U.S.	403	7.86	7.87	354	190	183
U.S. (1945)	418	6.10	5.68	388	153*	147*

* Authors' calculations.

TABLE 17—*Revenue Sources, by Volume Groups*

Volume Group	Revenue Source						Total	Free Service Value
	Resid.*	Coml.†	Ind.‡	Munic.	Fire	Misc.		
	Per Cent of Total Revenue							
1	61	17	13	1	4	4	100	3
2	54	20	17	1	4	4	100	2
3	52	16	21	1	4	6	100	2
4	53	15	23	1	3	5	100	2
5	60	16	15	1	3	5	100	1
6	51	22	16	2	2	7	100	2
7	50	28	11	1	2	8	100	2
U.S.	53	20	17	1	3	6	100	2

* Residential service. † Commercial service. ‡ Industrial service.

TABLE 18

Per Capita Operation and Maintenance Costs, by Volume Groups

Volume Group	No. of Cities	Per Capita Cost—$					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	28	2.09	8.81	4.40	3.37	4.07	5.07
2	82	1.74	11.83	4.77	3.48	4.38	6.09
3	83	2.06	9.86	4.30	3.03	3.75	5.14
4	66	1.53	7.95	4.17	3.11	4.05	4.92
5	46	1.49	8.21	3.99	2.83	3.54	4.72
6	46	1.79	8.54	3.98	3.05	3.81	4.64
7	7	2.11	5.52	3.64	(3.06)	3.43	(4.12)
U.S.	358	1.49	11.83	4.28	3.16	3.95	5.15

TABLE 19

Operation and Maintenance Costs per Million Gallons Produced, by Volume Groups

Volume Group	No. of Cities	Costs—*$/mil gal*					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	28	70	339	150	110	135	185
2	81	42	277	120	86	118	150
3	83	31	207	88	60	83	105
4	65	22	224	89	66	83	107
5	46	24	158	78	55	72	99
6	45	28	168	75	52	68	92
7	7	36	80	48	(36)	44	(65)
U.S.	355	22	339	98	64	88	126
U.S. (1945)*	388	14	384	75	48	66	95

* Authors' calculations.

TABLE 20

Operation and Maintenance Costs, by Population Groups

Pop. Group	Costs—*$/capita*			Costs—*$/mil gal*		
	No. of Cities	Mean	Median	No. of Cities	Mean	Median
1	137	4.74	4.33	124	111	101
2	102	4.44	4.19	93	103	90
3	56	4.07	3.70	54	93	94
4	42	3.77	3.33	41	80	72
5	27	3.82	3.63	27	84	82
6	16	3.80	3.13	15	65	56
U.S.	380	4.35	4.00	354	98	88
U.S. (1945)	417	3.02	2.73	388	75*	66*

* Authors' calculations.

TABLE 21

Breakdown of Total Expense, by Volume Groups

Volume Group	No. of Cities	Cost Element—*per cent of total*						Total Expense	
		Op.	Maint.	Wages	Depn.	Taxes	Misc.	*per cent*	*$/mil gal**
1	22	23	13	37	10	13	4	100	206
2	51	28	13	36	11	6	6	100	155
3	48	25	12	38	13	7	5	100	118
4	47	29	9	38	15	6	3	100	117
5	27	23	9	38	16	9	5	100	111
6	31	25	7	41	16	9	2	100	103
7	4	28	11	37	19	2	3	100	63
U.S.	230	27	10	39	14	6	4	100	128

* Mean value.

TABLE 22

"Revenue Less Expense," by Volume Groups

Volume Group	No. of Cities	Revenue Less Expense—*$/mil gal*					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	28	*−18*	158	61	38	56	76
2	81	*−73*	187	57	30	54	87
3	83	*−21*	191	61	25	54	86
4	65	*−33*	243	59	34	45	76
5	46	*− 4*	262	65	25	55	95
6	45	3	211	58	33	48	68
7	7	13	58	32	(19)	29	(46)
U.S.	355	*−73*	262	60	30	50	85
U.S. (1945)*	388	*−84*	370	61	30	52	83

* Authors' calculations.

TABLE 23

Revenue Less Expense and Bond Interest, by Volume Groups

Volume Group	No. of Cities	Revenue Less Expense and Interest—*$/mil gal*					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	28	*−18*	117	52	30	50	71
2	81	*−81*	161	46	24	42	66
3	83	*−30*	186	48	23	43	70
4	65	*−33*	143	41	20	35	64
5	46	*−44*	200	50	21	44	70
6	45	1	184	43	22	32	48
7	7	12	36	21	(13)	19	(30)
U.S.	355	*−81*	200	46	22	40	67
U.S. (1945)*	388	*−84*	284	48	22	41	67

* Authors' calculations.

TABLE 24

Operating Ratio, by Population Groups

Pop. Group	No. of Cities	Operating Ratio					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	136	1:0.9	1:4.5	1:2.1	1:1.6	1:1.9	1:2.3
2	102	1:0.7	1:3.6	1:2.1	1:1.6	1:1.9	1:2.6
3	55	1:1.1	1:4.5	1:2.2	1:1.7	1:1.9	1:2.5
4	42	1:1.2	1:4.6	1:2.4	1:1.7	1:2.2	1:2.7
5	27	1:1.3	1:5.2	1:2.5	1:2.0	1:2.3	1:2.6
6	16	1:1.1	1:3.1	1:2.0	1:1.5	1:1.7	1:2.4
U.S.	378	1:0.7	1:5.2	1:2.1	1:1.6	1:2.0	1:2.5

TABLE 25

Book Value, by Population Groups

Pop. Group	No. of Cities	Per Capita Book Value—$					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	129	8.85	151.18	66.01	46.63	63.25	79.38
2	98	11.00	235.19	65.71	43.44	60.00	77.07
3	59	4.99	154.72	66.80	46.75	64.38	81.78
4	44	17.13	157.50	65.68	45.00	60.00	77.50
5	27	40.96	161.04	85.37	59.18	81.25	115.63
6	18	33.07	122.82	73.89	55.00	70.00	87.50
U.S.	375	4.99	235.19	68.00	46.25	63.25	81.00
U.S. (1945)	357	7.84	437.37	56.73	38.33	50.01	66.14

TABLE 26

Book Value, by Volume Groups

Volume Group	No. of Cities	Per Capita Book Value—$					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
1	25	25.00	108.94	56.19	37.50	52.50	71.87
2	80	8.85	109.24	59.00	44.61	60.55	72.73
3	84	11.00	235.19	70.06	47.26	62.22	81.67
4	66	4.99	153.38	62.73	43.21	56.36	77.50
5	44	19.97	166.20	76.38	52.50	68.88	85.00
6	46	19.50	163.17	78.91	49.45	74.00	105.00
7	8	50.29	122.82	79.58	(58.24)	74.14	(99.38)
U.S.	353	4.99	235.19	68.00	46.25	63.25	81.00

TABLE 27—*Rate Schedules, by Volume Groups*

Volume Group	No. of Cities	Min.	Max.	Mean	1st Q.	Median	3rd Q.
		Monthly Rate—*$/1,000 cu ft*					
1	26	1.00	5.00	2.82	2.02	3.00	3.15
2	85	1.00	4.95	2.63	2.00	2.60	3.00
3	90	0.80	5.24	2.36	1.69	2.22	3.00
4	74	1.00	5.41	2.25	1.50	2.21	2.70
5	46	1.00	4.17	2.02	1.50	2.02	2.40
6	51	0.68	4.50	1.89	1.37	1.80	2.33
7	8	0.60	2.00	1.25	(0.98)	1.22	(1.49)
U.S.	380	0.60	5.41	2.30	1.60	2.20	2.83
U.S. (1945)*	368	0.50	4.25	1.94	1.40	1.88	2.40
		Monthly Rate—*$/10,000 cu ft*					
1	26	9.40	44.66	21.00	16.00	19.70	26.10
2	85	3.75	40.01	19.00	14.40	19.00	22.00
3	90	6.33	38.49	17.20	11.95	16.15	21.20
4	74	6.92	37.09	16.95	12.00	15.80	20.00
5	46	6.85	31.50	15.55	10.50	14.55	20.30
6	51	6.47	28.77	15.10	11.00	15.00	18.00
7	8	6.00	15.00	10.20	(7.00)	9.45	(14.00)
U.S.	380	3.75	44.66	17.20	12.00	16.50	21.00
U.S. (1945)*	369	3.00	32.81	14.30	10.25	13.80	18.00
		Monthly Rate—*$/100,000 cu ft*					
1	26	60.00	275.00	141	91	136	179
2	85	26.75	375.00	132	95	124	159
3	90	42.33	267.50	111	79	104	136
4	74	47.72	243.38	118	83	106	143
5	46	54.00	210.74	107	79	102	133
6	51	40.90	206.57	112	83	106	137
7	8	60.00	118.02	84	(68)	84	(109)
U.S.	380	26.75	375.00	118	84	109	142
U.S. (1945)*	367	15.00	250.17	98	70	92	130
		Monthly Rate—*$/1,000,000 cu ft*					
1	26	196.50	2,250.00	1,160	750	1,140	1,530
2	84	146.25	3,750.00	1,080	730	965	1,300
3	90	244.95	2,517.50	860	580	780	1,050
4	72	296.83	2,131.25	925	695	810	1,085
5	46	320.76	2,025.00	835	595	755	1,010
6	51	221.75	1,817.57	845	610	765	1,000
7	8	598.54	900.37	705	(606)	690	(766)
U.S.	377	146.25	3,750.00	935	640	810	1,130
U.S. (1945)*	360	92.55	2,500.17	800	540	720	1,020

* Authors' calculations.

TABLE 28

Rate Schedules, by Geographic Regions

Region	No. of Cities	Monthly Rate—*$/10,000 cu ft*					
		Min.	Max.	Mean	1st Q.	Median	3rd Q.
New England	41	6.33	30.00	16.90	13.70	16.80	20.50
Middle Atlantic	63	5.66	37.09	18.10	12.50	17.50	21.30
South	62	10.15	38.49	19.40	16.20	19.60	22.50
N. East Central	75	3.75	40.01	16.10	9.90	16.70	20.90
N. West Central	82	6.75	44.66	16.70	11.70	15.20	20.40
Mountain	12	7.00	35.20	13.00	(11.00)	12.00	(15.00)
Pacific Coast	44	6.95	21.76	14.90	10.20	13.50	17.00
U.S.	379	3.75	44.66	17.00	12.10	16.60	20.90

TABLE 29

Comparison of Privately and Publicly Owned Utilities

Item	Public (Mean Value)	Private	
		Mean Value	Per Cent Above Public Mean
Production—*gpcd*	139	124	−11
Sales—*gpcd*	111	99	−11
Per cent sold	83	83	0
Monthly rates—$			
1,000 cu ft	2.25	2.90	29
10,000 cu ft	16.90	21.00	24
100,000 cu ft	116	136	17
1,000,000 cu ft	930	970	4
Minimum charge—$	1.00	1.10	10
Allowance on minimum—*cu ft*	500	390	−22
Revenue—*$/mil gal*	184	234	27
Expense—*$/mil gal*			
Op., maint., and wages	98	104	6
Depreciation	17	17	0
Taxes	3	51	1,600
Miscellaneous	6	2	−67
Total	124	174	40
Income—*$/mil gal*			
Revenue less expense	60	60	0
Less bond interest	13	20	54
Net income	47	40	−15
Operating ratio	1:2.1	1:2.3	10
Book value—*$/cap.*	68	63	− 7
Debt—*$/mil gal**	440	650	48

* In terms of annual production.

TABLE 30

Comparison of 1945 and 1950 Survey Data

Item	1945		1950		
	Mean	Median	Mean	Median	Per Cent Above 1945 Value†
Production—*gpcd*	125	110	138	122	10
Sales—*gpcd*	99	89	110	98	10
Per cent sold	81	83	83	84	2
Monthly rates—$					
1,000 cu ft	1.94	1.88	2.30	2.20	18
10,000 cu ft	14.30	13.80	17.20	16.50	20
100,000 cu ft	98	92	118	109	20
1,000,000 cu ft	800	720	935	810	15
Revenue—*$/mil gal*	153	147	188	183	24
Expense—*$/mil gal*					
Op., maint., and wages	75	66	98	88	32
Depreciation	12	21	17	26	33
Taxes	5	8	8	12	55
Miscellaneous	‡	‡	5	7	
Total	92	95	128	133	40
Income—*$/mil gal*					
Revenue less expense	61	52	60	50	− 3
Less bond interest	13	11	14	10	0
Net income	48	41	46	40	− 4
"Revenue less expense" as per cent revenue	40	35	32	27	−21
"Net income" as per cent revenue	31	28	24	22	−22
Revenue—*$/cap.*	6.10	5.68	7.86	7.87	34
Op., maint., and wages—*$/cap.*	3.02	2.73	4.35	4.00	45
Operating ratio	1:2.2	1:2.0	1:2.1	1:2.0	− 2
Book value—*$/cap.*	57	50	68	63	22
Debt—*$/mil gal**	400	250	470	330	23

* In terms of annual production.
† Average variation of mean and median values.
‡ Not tabulated in 1945.

Correction

Since the publication of "A Survey of Operating Data for Water Works in 1950" (June 1953 issue, pages 583–678), a number of errors in the tabulation have come to light. These are noted in the table below:

City	Table	Page	City No.	Column No.	Reads	Should Read
Concord	2	616	85	1	N.H.	N.C.
Detroit, Mich.	1	595	99	16	3,568.5	5,568.5
				17	1.88	2.94
				18	1:4.2	1:2.7
East Chicago	1	594	101	1	Ill.	Ind.
Johnson City, N.Y.	3	648	186	5	4.5	108.4
				7	8.7	4.5
				8	—	8.7
Johnson City, Tenn.	1	599	187	16	93.4	103.4
				17	2.75	3.04
				18	1:3.6	1:3.3
Kansas City, Mo.	1	599	192	16	1,162.0	2,162.0
				17	2.54	4.73
				18	1:2.9	1:1.6
Latrobe, Pa.	1	601	205	15	1.49	14.90
Petersburg, Va.	2	626	291	2	12,547.0	1,254.7
				3	8,782.9	878.3
Syracuse, N.Y.	4	677	372	5	3,278.00	1,110.00
Yakima, Wash.	2	632–3	415	2	412.3	3,091.9
				3	207.9	1,559.0
				5	269	202
				6	136	102
				11	40.3	30.3

1953 Conference—Grand Rapids

PAUL BUNYAN it was, who played host to AWWA's seventy-third annual conference last May 10–15 at Grand Rapids, Mich. Small wonder, then, that every aspect of the meeting was a tremendous success: the 40 full hours of technical papers and discussion, the 30 or more committee and other official meetings, the 16,000 sq ft of exhibits, the five fine evenings of eating and entertainment, the opportunity to inspect the world's first fluoridation plant, and the wonderful friendliness and enthusiasm that kept the 1,897 registrants doing things together all during the week. And if the registration total didn't quite measure up to the records of the past few years, it was primarily because water workers had already overflowed not only the hotels, but the motels and tourist homes as well —all of which made even "not quite biggest" Bunyanesquely magniloquent.

Right-hand man to Paul the Mighty Logger was Michigan's Ned Barrett, chairman of a Convention Management Committee which included:

Representing AWWA	*Representing WSWMA*
W. Leslie Harris	T. T. Quigley
T. L. Vander Velde	E. A. Sigworth

Ex Officio

Charles H. Capen, *President*	Carl N. Brown, *President*
Harry E. Jordan, *Secretary*	John G. Stewart, *Manager*
Richard Hazen, *Chm., Publication Com.*	

It was Dick Hazen and his program committee who worked up the full 40-hour week of technical temptation, and it is to their credit, as well as that of the 85 programmers, that little of Paul's wood was sawed during the sixteen sessions that kept two meeting rooms full of attention and discussion all day every day. The half-hundred titles which channeled the discussion are listed on pages 1341–42. Almost all that was read has since been published in the Journal; almost all that was said, however, has had to go unrecorded, except in the memories of those who participated in sessions both sizzling and scintillating.

Scintillating, too, were the offerings of the 87 manufacturers who displayed their wares in 144 booths set up by John Stewart and his Exhibit Committee in Grand Rapids' capacious Municipal Auditorium. And it was there, in the shiny shadow of progress and efficiency, that water workers spent every minute of their free time, shopping, shoptalking, or just mouthwatering.

Free time never extended into the evenings, though, for almost the minute that meetings and exhibits shut down, Tom Quigley's General Entertainment Committee was ready to take over. Beginning on Sunday evening with a Dutch Buffet that preceded the customary "Meet and Greet" affair, the social calendar

1953 CONFERENCE STATISTICS

Grand Rapids Registration by Days

Day	Men	Ladies	Total
Sunday, May 10	816	215	1,031
Monday, May 11	493	141	634
Tuesday, May 12	122	9	131
Wednesday, May 13	62	—	62
Thursday, May 14	39	—	39
TOTALS	**1,532**	**365**	**1,897**

Geographic Distribution of Registrants

UNITED STATES & TERRITORIES

Alabama	31	Michigan	307	Virginia	22
Arizona	8	Minnesota	27	Washington	9
Arkansas	9	Mississippi	4	West Virginia	19
California	61	Missouri	60	Wisconsin	51
Colorado	21	Montana	3		
Connecticut	13	Nebraska	8	**CANADA, CUBA & FOREIGN**	
Delaware	2	New Jersey	89		
Dist. Columbia	9	New Mexico	1	Bolivia	1
Florida	25	New York	155	Canada	36
Georgia	31	North Carolina	15	Costa Rica	1
Hawaii	2	North Dakota	6	Cuba	4
Illinois	200	Ohio	159	Egypt	1
Indiana	75	Oklahoma	9	Germany	1
Iowa	44	Oregon	5	Great Britain	3
Kansas	21	Pennsylvania	167	Japan	2
Kentucky	19	Puerto Rico	2	Panama	1
Louisiana	23	Rhode Island	20	Peru	2
Maryland	4	South Carolina	11	Surinam	1
Massachusetts	25	South Dakota	8	Venezuela	2
		Tennessee	21		
		Texas	34	**TOTAL**	**1,897**
		Utah	3		

Comparative Registration Totals—1944–1953

Year	Place	Men	Ladies	Total
1953	Grand Rapids	1,532	365	1,897
1952	Kansas City	1,600	386	1,986
1951	Miami	1,415	491	1,906
1950	Philadelphia	1,678	329	2,007
1949	Chicago	1,593	374	1,967
1948	Atlantic City	1,348	356	1,704
1947	San Francisco	1,115	431	1,546
1946	St. Louis	1,303	214	1,517
1944	Milwaukee	1,185	171	1,356

Win, Place & Show in Section Awards

Henshaw Cup		Hill Cup		Old Oaken Bucket	
Cuban	**71.6%**	**Nebraska**	**40.68**	**California**	**1,021**
Montana	67.8%	Kansas	18.87	Southwest	729
Ala.-Miss.	64.5%	Rocky Mt.	18.63	New York	725

included a presentation of awards, the officers' reception and ball, Paul Bunyan's evening of hair-down hilarity, a program by the Dutch Klompen Dancers, and, finally, the annual banquet and inaugural ball. Meanwhile, it was Esther Harris who hostessed the ladies to a week of fun, fashion, and furniture, topped off by a visit to Holland, Mich., during the Tulip Festival.

Providing the participants for all this activity, of course, was AWWA's perennial routemaster, Sig Sigworth, and his transportation committee. And keeping them happy on arrival and throughout were Les Harris, Ted Vander Velde, Doug Feben, Earl Norman, Harry Caswell, George Hazey, and a total of 89 other Michigan Section water workers and their wives, whose hospitality and good works even Paul couldn't exaggerate.

Association Awards

Honorary Membership was conferred upon Wendell R. LaDue, of Akron, Ohio, and Reeves Newsom, of Scarsdale, N.Y. The citations follow:

WENDELL RICHARD LADUE, Chief Engineer and Superintendent, Bureau of Water and Sewerage, Akron, Ohio: *a distinguished citizen in his community, whose public services are manifold; one who has served the Association well for many years in many phases of its activities; President of the Association in 1946–47 and presently Chairman of its Correlating Committee on Water Works Administration.*

REEVES NEWSOM, Village Manager, Scarsdale, N.Y.: *a faithful servant of the public as an administrator of water works systems under both public and private ownership; lately a consulting engineer of high competence; presently manager of his community's public administration; President of the Association 1938–39; a loyal member who has given generously of his time and talents to the administrative affairs of the Association.*

The John M. Diven Medal, awarded to the member whose services to the water works field during the preceding year are deemed most outstanding, was presented to James E. Kerslake. The citation follows:

JAMES EARL KERSLAKE, Superintendent of Filtration, Water Purification Plant, Milwaukee, Wis.: *in recognition of his outstanding contributions to water purification progress through his service as coordinator in the preparation of a series of specifications and test documents covering the principal chemicals used in the treatment of water.*

The John M. Goodell Award, granted for the best paper published in the JOURNAL during the past year, was conferred upon Edward W. Moore. The citation follows:

EDWARD WARREN MOORE, Associate Professor of Sanitary Chemistry, Division of Applied Science, Harvard University, Cambridge, Mass.: *for his paper*

entitled "The Precision of Microscopic Counts of Plankton in Water," which was published in the March 1952 issue of the Journal (Vol. 44, page 208). *This paper will be found useful not only in defining a method of evaluating the precision of microscopic counts but also in indicating the causes of unsatisfactory records. Appreciation of the precision of any analytical procedure is essential in the intelligent examination of water.*

The George Warren Fuller Awards were presented to 28 men whose Sections had nominated them in the year beginning with the 1952 Annual Conference at Kansas City and ending with the opening of the 1953 Annual Conference at Grand Rapids. The awards—which are conferred for "distinguished service in the water supply field and in commemoration of the sound engineering skill, the brilliant diplomatic talent, and the constructive leadership of men in the Association which characterized the life of George Warren Fuller"—went to the following men:

Arizona Section—HAROLD WINANS YOST: scholar, engineer, friend, and devoted worker for years for the benefit of the Association and the industry.

California Section—JOHN STALKER LONGWELL: for his noteworthy contribution to water works practice and to the reputation of the California Section through his exemplary management of the East Bay Municipal Utility District; and for his unselfish service in the coordination of civil defense activities.

Canadian Section—OSWALD HAYWARD SCOTT: for his competent administration and management of a water works utility; and his notable contributions to, and effective cooperation in, the activities of the Canadian Section.

Chesapeake Section—EDWARD BREDELL SHOWELL: for his long and untiring service to the Section and Association; his invaluable contributions in the field of water conditioning; and his inspiration and guidance in the training of young engineers.

Cuban Section—LAURENCE HANDY DANIEL: for his outstanding loyalty and faithfulness of service to the Section; and for his praiseworthy contributions to the advancement of the water supply industry in Cuba.

Florida Section—HARRY THOMAS OBERLY: for his administrative ability, technical skill, and qualities of leadership, with which he has guided the development of one of Florida's most rapidly growing water systems; and for his long and devoted service to the Florida Section.

Illinois Section—ARTHUR MOSES BUSWELL: for his many contributions to the science of water treatment; his achievements in the development of the State Water Survey; and his many other valuable services to the Section, the water systems of Illinois, and the industry as a whole.

Indiana Section—HOWARD SCOTT MORSE: for the inspiration, guidance, and example to others in the application of sound water works practice to the utility under his management; for his active leadership in civic affairs; and for his years of service to the Association.

Iowa Section—JOHN ROBERTSON BARNES (deceased): in recognition of his long and valued service to the industry; his untiring and effective promotion of membership; and his unselfish attitude and genial personality, which have endeared him to all water works men in the state.

Kansas Section—MAJOR CALLAWAY HAGAR: for his enthusiastic and effective participation in all phases of Section activity; his active interest in the field of water treatment; and in recognition of his able leadership during the 1951 flood emergency at Lawrence, Kansas.

Kentucky-Tennessee Section—JOHN WILEY FINNEY JR.: for his constructive participation in the affairs of the Section; his contribution to programs for improving water works practice and training operators; and his services in developing a sound policy for the fluoridation of water supplies in Tennessee.

Michigan Section—JOHN FREDERICK DYE: for his many contributions to the knowledge of water chemistry; and for his devoted efforts as a member of the Board of Examiners for Certification and as a committeeman and officer of the Section.

Minnesota Section—ALEXANDER CHARLES JANZIG: for his more than thirty years of valuable service in the water treatment plants of Minneapolis; his outstanding contributions as chairman of the Section's membership committee; and his distinguished leadership of the water works school.

Missouri Section—ROGER CHASE HIGGINS: in recognition of his tireless and persistent efforts on behalf of the Missouri Section and his constant promotion of the welfare of all water works men through his committee activities.

Montana Section—FRANCIS FREDERICK PALMER: for his loyal interest and leadership in Section affairs.

Nebraska Section—HARRY LANE MORRIS: for his efficient and successful improvement and operation of his city's water system; and for his contributions to and deep interest and untiring efforts in the promotion of the Nebraska Section.

New England Section—WARREN JOSEPH SCOTT: in recognition of his unstinting devotion to the improvement of water supply quality; his wise leadership in the administration of environmental public health policies; and his loyalty to the ideals of the water works profession.

New Jersey Section—GEORGE FREDERICK WIEGHARDT: in recognition of his long and outstanding service to the largest private water company in New Jersey; and for his loyal aid to the New Jersey Section from the time of its founding.

New York Section—HARRY EDWARD JORDAN: in recognition of his many years of distinguished and outstanding service in the development of sound water works practice, his constant efforts toward the advancement of the water works industry, and his promotion of the welfare of all water works men.

North Carolina Section—HAROLD FRANKLIN DAVIS: in recognition of his work on committees and in offices of the Section; his outstanding services over many years as a teacher in the water works operators schools; and his technical assistance on water-conditioning problems.

Ohio Section—EARL L. COLEMAN: in recognition of his continued and outstanding achievements in promoting the Association as chairman of the Section's membership committee and his constant devotion to AWWA.

Pacific Northwest Section—JOHN WILBUR CUNNINGHAM: in recognition of his excellent engineering work in the planning and design of water supplies in the Pacific Northwest; and his long and continuous services in the development of the Section.

Pennsylvania Section—HARRY MORTIMER FREEBURN: in recognition of a lifetime of devoted service and outstanding achievement in the interest of public health; and his valuable efforts in the advancement of national and regional water works organization.

Rocky Mountain Section—ADOLPH DELINUS MARS JR.: for his long and untiring support of the Rocky Mountain Section, particularly the educational campaign designed to interest city officials in AWWA membership.

Southeastern Section—JOHN LIDDELL HAWKINS: in recognition of his distinguished service as administrator in the water supply industry of the southeastern states; and his exemplary management of the Greenville City Water Supply System.

Southwest Section—ROBERT O. GRESHAM: for his long and faithful service to the water works industry, particularly through the medium of the *Southwest Water Works Journal*, and his services at Section meetings; and for all his untiring activities to further the interests of the Section and the Association.

Virginia Section—MICHAEL JOHN SIEBERT: for his loyal and individual efforts, continuously given to the Virginia Section since its foundation, which have materially benefited the operators of water supplies throughout the commonwealth.

West Virginia Section—LAWSON HAYNES: for his inspiration and assistance in the training of young operators; and for the advancement of his community's interest in water treatment through many hours of effort expended in the technical instruction of public groups.

The Nicholas S. Hill Jr. Cup, awarded annually to the Section making the largest weighted gain in membership, was won by the Nebraska Section with 40.68 points.

The Henshaw Cup, awarded annually to the Section having the greatest percentage of its members present at the Section's annual meeting, went to the Cuban Section, which scored 71.6 per cent.

The Old Oaken Bucket, awarded to the largest Section in the Association, was presented to the California Section for the fourteenth year in succession.

Schedule of Conference Papers and Reports

Water Works Management Division—9:30 AM—May 11, 1953

Meeting the Needs of Fringe Developments ..... Frederick Wegner
Committee Report—Water Main Extensions ..... L. S. Finch
Management and Operation of Saginaw-Midland Supply Line ..... Alfred Eckert

Water Purification Division—9:30 AM—May 11, 1953

Activation of Silica ..... C. A. Black
Discussion ..... A. E. Griffin
Stationary Storage of Liquid Chlorine ..... A. S. Woodard and L. L. Hedgepeth
Application of the Microstrainer to Water Treatment in Great Britain ..... Richard Hazen
Discussion ..... P. L. Boucher, A. A. Kalinske, A. W. Consoer

Joint Open Session—Correlating Committees—2:00 PM—May 11, 1953

Committee Report—Water Works Administration ..... Wendell R. LaDue
Committee Report—Water Works Practice ..... Louis R. Howson

Water Purification Division—2:00 PM—May 11, 1953

Committee Reports .....
A Reexamination of Oliogodynamic Disinfection ..... Charles Renn

Water Works Management Division—9:30 AM—May 12, 1953

Committee Report—Water Use in Air Conditioning ..... Frank C. Amsbary
Demand Charge for Air-Conditioning Use in Arkansas ..... J. R. Pierce
Committee Report—Water Rates ..... Louis E. Ayres
Promoting Better Public Understanding of What Water Works Service Is Worth .....
M. B. Cunningham, W. V. Weir, L. R. Howson, J. H. Murdoch, and S. B. Morris

Water Purification Division—9:30 AM—May 12, 1953

Do We Need a New Water Quality Yardstick? ..... W. A. Mallmann
Discussion ..... F. W. Gilcreas
Waterborne Outbreaks—A Statistical Study ..... Abel Wolman, William T. Ingram, and A. E. Gorman
Panel Discussion—Lime-softened Water ..... *Led by* Merrill L. Riehl
Effects on Bacteriological Quality ..... H. O. Hartung
Effects on Main Disinfection ..... Paul C. Laux
Effects on Zinc-bearing Metals ..... Walter Muhlitner

Transmission and Distribution Division—2:00 PM—May 12, 1953

Panel Discussion—The New ASA Standards for Cast-Iron Pipe
Their Development ..... Thomas H. Wiggin
Manufacturing Considerations ..... J. Thompson Vann and H. W. Stuart
A Consulting Engineer's Appraisal ..... L. R. Howson
A Manager's Appraisal ..... W. R. LaDue
Studies on the Mechanism of Corrosion ..... Rolf Eliassen and James C. Lamb III
Cast-Iron Pipe Coatings as Related to Corrosion ..... John R. Baylis

Water Works Management Division—2:00 PM—May 12, 1953

Panel Discussion—A Safety Program for the Water Works Industry
Introduction ..... R. J. Faust
Supply ..... Jerome Powers
Treatment and Pumping ..... Oscar Gullans
Distribution ..... Kenneth A. Day
Administration ..... Rodney A. Edwards

Water Resources Division—9:30 AM—May 13, 1953

Managing the Missouri River Projects ..... Dale L. Maffitt
Developing and Controlling Kansas' Rivers—An Engineering Analysis and Report ..... N. T. Veatch, L. R. Howson, and Abel Wolman
Predicting Fluctuations in the Michigan-Huron Lake System ..... John E. Vogt and Donald M. Pierce

Transmission and Distribution Division—9:30 AM—May 13, 1953

Motor Drives for Water Pumping ..... E. O. Potthoff and M. C. Boggis
Application of Vertical Pumps to Water Works Practice ..... Thomas M. Niles
Control of Water Pressure on Suburban Distribution Lines ..... J. S. Williams
Discussion ..... L. S. Finch
Committee Progress Report—Water Hammer ..... S. Logan Kerr and Hugh Kennison

General Session—2:00 PM—May 13, 1953

Panel Discussion—The Highway Improvement Problem ..... Harry B. Shaw, John W. Cramer, A. O. Norris, and H. E. Jordan
Task Group Report—Training Water Works Personnel Through Schools and Conferences .. R. J. Faust, E. S. Hopkins, Fred Merryfield, A. P. Black, and E. R. Stapley

Water Resources Division—9:30 AM—May 14, 1953

Committee Report—Ground Water Pollution Control ..... Norman F. Billings
Committee Report—Erosion Control on Reservoir Areas ..... B. S. Grant
Effects of Beetle Infestations on Watersheds ..... D. S. Nordwall
Committee Report—Water Conservation Methods Used in Industry ..... H. E. Hudson
Interpretation of Pumping Test Data for Wells ..... Russell H. Brown

Transmission and Distribution Division—9:30 AM—May 14, 1953

Design, Construction, and Functional Relationships of the New North Jersey District Water Supply Line ..... C. H. Capen
Design of Wye-Branch Fittings..... H. J. Chapton, H. S. Swanson, Carlton L. King, and W. J. Wilkinson
Panel Discussion—Plastic Service Pipe .... M. E. Flentje, Max Socha, and W. D. Tiedeman

Joint Session—Water Resources and Water Purification Divisions—2:00 PM—May 14, 1953

Panel Discussion—Effect of Irrigation Runoff on Surface Water Supplies ..... *Led by* M. B. Cunningham, Paul D. Haney, Thomas W. Bendixen, C. S. Howard, and J. K. G. Silvey
Controlling Industrial Pollution of the Passaic River ..... Frank DeHooge
The Effects of Synthetic-Detergent Pollution on the Operation of a Public Water Supply Softening Plant ..... Russell L. Culp and Howard Stoltenberg

General Session on Fluoridation—9:30 AM—May 15, 1953

An Evaluation of Fluorides in North Dakota Water Supplies ..... A. E. Williamson and J. H. Svore
Defluoridation of Municipal Water Supplies ..... F. J. Maier
A Rational Approach to Fluoridation ..... J. E. McKee
How a Health Commissioner Looks at Fluoridation ..... A. E. Heustis

Papers Scheduled at 1953 Section Meetings

THERE follows a summary listing of papers scheduled for presentation at 1953 Section Meetings. The dates of the Section Meetings from 1948 to 1953 and the locations for 1953 are listed on page 1354. Section officers who were elected at meetings held during 1953 are listed on page 4 P&R in the front of this issue. The programs are listed alphabetically by Sections, without regard to the date of presentation.

Alabama-Mississippi Section—October 4–7, 1953

Report on Fluoridation in Alabama and Mississippi to Date ..... W. E. Hooper
Pump Operation and Maintenance ..... John L. Snow
Billing Methods for Small Operations ..... W. O. Haggard
Fire Protection Requirements ..... R. H. Tucker
Water Conservation—Necessity and Methods ..... Frank G. Crow
Minimum Standards for Water Distribution Systems ..... J. C. Clarke
Panel Discussion—How Do You Do It? ..... *Led by* Jess L. Haley
- Meter Reading ..... A. N. Fitzsimmons
- Meter Maintenance ..... Roy Stott
- High-Bill Complaints ..... Guy E. McAliley
- Valve Maintenance ..... J. Earl Ham
- Hydrant Maintenance ..... T. H. Collins
- Public Relations ..... Fred Scott Jr.

Arizona Section—April 16–18, 1953

Address of Welcome ..... *Mayor* Otho L. Dixon
Response ..... M. P. Goudy
Algae Symbiosis ..... Harvey F. Ludwig
Choosing the Appropriate Differential Producer in Main-Line Metering ... E. J. Waltenspiel
Symposium on Pipe for Water Works
- Concrete Pipe ..... Elliott E. Brainard
- Steel Pipe ..... Walter H. Cates
- Cast-Iron Pipe ..... Clark Webb
- Asbestos-Cement Pipe ..... A. W. Miller

Can We Design Better Valve Boxes? ..... John Rauscher
ABC of Electricity for Operators ..... Paul Rist
Simple Hydraulics—Phase 2 ..... John Schaefer
Simple Tests for Sewage and Water Treatment Plants ..... Alice L. Mathis
Fact, Fallacy, and Philosophy ..... W. H. Wisely
The Corey Sleeve ..... William Corey
The Barminutor ..... Miles Lamb
Types of Wells for Water Works ..... Leigh Gardner
Biofiltration ..... William Budd
Clouds and Their Meaning ..... Louis R. Jurwitz
Water Hammer ..... Art Beard

California Section—October 27–30, 1953

Welcome ..... *Mayor* Elmer E. Robinson
Response ..... Laurance E. Goit
Liquid Assets of the East Bay Municipal Utility District ..... John W. McFarland

Protection of the Sanitary Quality of Water in the Distribution System .....E. A. Reinke
Improvements in Operation Through Better Administrative Practices .....M. J. Shelton
Construction Joints in Concrete Floors of Reservoirs .....L. A. Hosegood
New Developments in Water Well Photography .....Claude Laval Jr.
Water Works Problems in Small Towns .....John C. Hayes
Cutting Pipe in Place .....O. G. Goldman
Design and Use of Precast Reservoir Roofs .....Carlos Yerby
Discussion .....Paul Beermann
Pumping With Internal-Combustion Engines .....C. A. Garnier
Tenth Edition of *Standard Methods*.....Louise Carty
Use of Ion-Exchange Resins in Water Analysis .....Remo Navone
Recent Applications of the Amperometric Titrator and the Chlorine Residual Recorder .....
Morley Weir
Carrying Free Residual Chlorination Through a Water Distribution System ..George Y. Blair
Problems Faced by Irrigation Districts Serving Domestic Water .....Loy Flor
Controlling Sand in Water Supply Systems .....John R. Rossum
Panel Discussion—Watershed Control for Domestic Water Supply Reservoirs .....
R. E. Dodson and Gordon Laverty
Looking Ahead in Labor Relations .....J. Hunter Clark
Public Relations and Opportunity for Your Water Department .....A. O. Putman
Management Attitudes Toward Safety Engineering .....Kenneth N. Beadle
Does Your Accountant Prepare Costs for Management? .....D. R. Malcolm Jr.
Panel Discussion—How to Lead Men .....William J. Stephens,
Ben Haggott, Lloyd D. Luckmann, Otto E. Never, and George C. Sopp
Underground Travel of Chemical and Bacterial Pollutants .....
P. H. McGauhey, R. G. Butler, and G. T. Orlob
Water-spreading Operations in the San Gabriel Valley .....Finley B. Laverty
Report .....Thomas T. Quigley
California Water Problems .....A. D. Edmonston
Status of California Civil Defense Plans .....John S. Longwell
The Effect of Federal Legislation on California Water Projects .....Clair Engle

Canadian Section—April 6–8, 1953

Guided Discussion—Assessment Procedure for Public Utilities Property ..*Led by* O. H. Scott
Establishment of Rates for the Recovery of Capital and Operating Costs Allocated to Fire Protection Service .....R. H. Ellis
Water Requirements for Community Fire Requirements .....J. N. Pryce
Scarborough's New Water Purification Plant .....Ronald Harrison and E. M. Proctor
Guided Discussion—Water Supplies for Large Urban and Adjacent Areas .....
Led by F. Y. Dorrance
Short Courses and Certification of Water Works Operators .....G. H. Strickland
The Buffalo Water Purification Plant .....F. W. Crane
Guided Discussion—Joints for Water Pipes .....*Led by* C. G. R. Armstrong
Algae Control in Water Works .....D. H. Matheson
The Initiation of a Metering Program for a City.....W. E. MacDonald
Guided Discussion—Current Problems in Water Works Systems .....*Led by* I. P. Macnab
Guided Discussion—Breaks in Water Distribution Systems .....*Led by* C. S. Anderson

Canadian Section—Maritime Branch—September 21–22, 1953

The Corner Brook Water System .....A. C. Northover
Guided Discussion—Problems in a Water Works System .....*Led by* A. F. Wigglesworth
Automatically Controlled Lime Treatment——Halifax Water System .....G. L. Renner
Ground Water Supplies in the Maritimes .....T. L. McManamna
Symposium on Fire Protection
Costs and Financing .....Ira P. Macnab
Underwriters' Inspection, Insurance Rates, and Sprinklers .....W. G. Shakespeare
Design, Construction, and Maintenance .....P. C. Ahern
Records—Why and How? .....V. M. Parrett and W. H. Debison

Chesapeake Section—October 28–30, 1953

Address of Welcome ..... *Mayor* August F. Walz
The Future Water Supply of Baltimore City ..... Joseph S. Strohmeyer
Discussion ..... G. S. Requardt, Abel Wolman, and Harry B. Shaw
Panel Discussion—Water Supplies—Better or Worse ..... *Led by* Robert L. Haywood Jr., W. McLean Bingley, D. K. Harmeson, and Edwin R. Cotton
Why Sanitation on Watersheds? ..... Edward S. Hopkins
Discussion ..... J. M. Jester
Watershed Control of Brandywine Creek ..... Clayton Hoff
Utility Changes Required by Highway Programs ..... Robert J. McLeod
Discussion ..... R. C. Willson
Panel Discussion—New Water Works Material and Equipment ..*Led by* Bernard L. Werner
Plastic Pipe Applications ..... J. C. Smith
Instrumentation and Controls ..... David A. Wood
Experiences With Mechanical-Joint Pipe ..... Roy L. Orndorff and Justin E. Farrell
Submersible Pumps for Municipal Application ..... J. L. Frensdorf
Occoquan Filter Plant ..... E. H. Aldrich
Panel Discussion—Special Filter Bottoms ..... *Led by* Carl J. Lauter
Leopold Bottoms ..... M. L. Stuppy
Wagner Bottoms ..... Dick Muller
Wheeler Bottoms ..... J. R. Hartley
Carborundum ..... F. C. Roe
The New Wilmington Filter Plant ..... Frank A. Marston

Cuban Section—December 3–5, 1953

Program not available.

Florida Section—October 11–13, 1953

Address of Welcome ..... *Mayor* Chelsie J. Senerchia
Response ..... Charles H. Helwick
Some General Problems of the Water Works Industry ..... Harry E. Jordan
An Island Water Supply ..... Geoffrey C. Stubbs
Projected Expansion of the Water Supply of Havana ..... Manuel J. Puente and Jose Garcia-Montes
Growth of Water Systems Due to Population Increases ..... Charles E. Richheimer
A County Commissioner Looks at His Water Problem and Its Solution .... R. Hosey Wick
Hydrogen Sulfide Problems in a Small Water Supply ..... Sidney W. Wells
Panel Discussion—Fluoridation ..... *Led by* A. P. Black, Floyd DeCamp, John V. Miner, and J. Ernest Edwards
Is Your Safety Program All Wet? ..... A. P. McIntosh
The Desalting of Sea and Other Saline Water ..... C. E. Reid and F. A. Eidsness
Panel Discussion—Water Main Extension Policies ..... *Led by* David B. Lee, Stanley Sweeney, W. F. Savidge Jr, Charles H. Helwick, Max D. Holmes, and William A. Glass
Water Rates ..... Harold D. Briely and Harry E. Wild
Modern Iron Removal Practices ..... Eskell Nordell
How to Keep 10,000 Bosses Happy ..... Lois J. Schulze
Preview of New Miami Southwest Water Treatment Plant Trip ..... C. F. Wertz

Illinois Section—March 18–20, 1953

Pollution of Surface Waters ..... C. W. Klassen
Discussion ..... Perry E. Miller
Pollution Loads and Their Effects on Plant Operation ..... John R. Baylis
Industrial Water Sales by Public Systems ..... W. J. Roberts

Water Rates for Industrial Users ..... Homer L. Chastain
Discussion ..... H. S. Merz and Melvin P. Hatcher
Research Needs in Water Works ..... L. C. Domke and Armon Lund
Municipal Versus Home Softening ..... T. E. Larson
Discussion ..... Glenn W. Bostrom
Bettering the Management Job ..... R. L. Peterson
Judging Radio and TV Programs via Water Consumption ..... James L. Weeks
Group Discussion on Operating Problems
Extensions Outside the City ..... Lester E. Culverson
Filtration Plant and Corrosion Problems ..... Henry A. Haferkamp
Operating Records ..... Maurice C. Stout
Meter Reading Practice ..... J. C. Moomau and Stephen C. Casteel
Saving Money Through Safety ..... Raymond J. Faust
Panel Discussion on Diversion of Water Works Funds .....
L. K. Crawford, Jason N. Daykin, and H. S. Merz
Financing Water Works and Water Works Improvements ..... Allan Blair

Indiana Section—February 11–13, 1953

Fluoridation of Public Water Supplies
Status of Fluoridation ..... F. J. Maier
Fluoridation in Indiana ..... Roy D. Smiley
Feeding and Control Problems .....
Paul G. Fulkerson, Robert J. Becker, and Marce Thalheimer
Discussion ..... George G. Fassnacht
Report on Water Works Legislation ..... Henry B. Steeg
Design of a Package Water Treatment Plant ..... E. H. Aldrich
Activated Silica as an Aid to Coagulation ..... A. E. Griffin
Discussion ..... M. P. Crabill, Harvey J. Goetz, and John A. Robbins
Red Water and Its Prevention ..... Philip S. Davy
Water Witching by Air Photo Interpretation .....
Robert Howe, Don E. Bloodgood, Harvey R. Wilke, and R. E. Frost
Dollars and Sense in Water Works Operation .....
Thomas J. Burrin, Charles L. Hale, and Howard W. Niemeyer
H.D. Broth as a One-Culture Medium for Coliform Organisms ..... S. R. Kin
Problems—The Water Works Kind
Raising an Elevated Tank ..... Harry J. Draves
Locating a Break in the Supply Line ..... Clyde Robbins
New-Main Headaches ..... L. L. Stone

Iowa Section—October 14–16, 1953

Address of Welcome ..... *Mayor* Lawrence A. Touchae
Response ..... Cliff W. Hamblin
Water Works Safety Program
Safety as Applied to a Water Works Utility ..... Quentin Wildman
Safety as Applied to Public Utilities ..... Harold Scendt
Panel Discussion—Corrosion Problems ..... *Led by* M. K. Tenny
Chemical Balance and Protective Film ..... M. E. Rew
Activated Silica ..... A. E. Griffin
American Standards Association Specifications for Cast-Iron Pressure Pipe .....
Thomas F. Wolfe
Panel Discussion—Water Works Management
Let's Go Fishing ..... E. L. Filby
Employee Relations ..... S. C. Casteel
Water Main Extensions ..... H. V. Pedersen

Small Water Works Problems ..... *Led by* Joe J. Hail
Reading, Billings, and Collections ..... Arthur E. J. Johnson
Water Meters and Maintenance ..... Glen V. Yarger
Distribution Maintenance ..... Herbert Murphy
Purchasing and Repairs on Hand ..... Francis M. Boag

Kansas Section—April 22–24, 1953

Municipal Bond Financing for Water Works Projects ..... Harold Null
Effects of Synthetic-Detergent Pollution on the Operation of a Public Water Supply Softening Plant ..... Russell L. Culp, J. J. Higgins, and Howard A. Stoltenberg
The Use of the McIlroy Analyzer in the Design and Analysis of Pipeline Networks ..... Glenn E. Hands
A Comparison of Water Treatment Methods as Used at the Oklahoma A. & M. Experimental Treatment Plants ..... Quentin B. Graves
Innocents Abroad ..... Gordon Mau
The Installation of Gate Valves in Water Mains Under Pressure ..... G. J. Manahan
Panel Discussion—Cutting the Costs of Sewage Treatment
Reducing Maintenance and Operation Costs ..... Kenneth Pack and D. B. Kissinger
Reducing Capital Expenditures for New Plants ..... O. O. Ediger and Ray Lawrence
Panel Discussion—Long Range Planning for Water Utilities
The City of Wichita Water Supply ..... Robert H. Hess
The Kansas City Suburban Water Company ..... L. S. McArthur
Looking Towards Water Softening ..... Murray A. Wilson
Forecasting Distribution Requirements ..... Harold Volkman
Research in the Possible Transmission of Histoplasmosis by Water ..... Dwight F. Metzler
Cathodic Protection of Submerged Steel Surfaces ..... F. A. Daniels
Problems Encountered in the Distribution System ..... Morrison B. Cunningham
Panel Discussion—Fluoridation Chemicals and Equipment
Flural as a Fluoridating Chemical ..... O. E. L. Haff
Hydrofluosilicic Acid as a Fluoridating Chemical ..... Paul J. Bush
Gravimetric Feeding of Sodium Silicofluoride ..... Anthony Younger

Kentucky-Tennessee Section—September 21–23, 1953

Address of Welcome ..... *Mayor* LeRoy Woodward
Response ..... Justin J. Davis
Sanity in Sanitation ..... E. Sherman Chase
Current Problems of the Water Works Industry ..... Harry E. Jordan
Preliminary Findings on Pollution Conditions in the Ohio River From Cincinnati, Ohio, to Cairo, Ill. ..... Robert K. Horton
Safety in Utility Plants ..... Robert W. Wilson
Civil Defense and Its Relation to the Water and Sewage Works Industries ..... J. S. Lindsay
The Expansion of the Owensboro Municipal Industries ..... E. A. Farmer
The Economics of Adequate Leak Surveys ..... Homer E. Beckwith
The Effect of Air Conditioning on Water Consumption and Distribution ..... Robert L. Lawrence Jr.
Activated Silica as a Coagulant Aid ..... A. E. Griffin
Taste and Odor Control ..... David C. Colebaugh Jr.
Public Relations—An Opportunity for Your Water Department ..... A. O. Putnam
What Is New in the Water Treatment Field in Kentucky and Tennessee ..... Nick G. Johnson and J. Wiley Finney Jr.
Water Works Operators Forum ..... *Led by* E. E. Jacobson
Cathodic Protection for Water and Sewage Works ..... Robert L. Spencer
Engineering Reports and Rate Studies for Water and Sewer Systems ..... J. Stephen Watkins
The Importance of the Engineering Report and Rate Studies From the Financier's Viewpoint ..... P. M. Conway

Michigan Section—September 3–4, 1953

Address of Welcome ..... *Mayor* Robert E. LeMire
Response ..... Edward D. Barrett
News of the Field ..... John E. Vogt
Compensation for the Superintendents of Water Works ..... Raymond J. Faust
Design Factors of the Escanaba Water Filtration Plant ..... Paul H. Johnson
Water Supplies in Disaster ..... T. L. Vander Velde
Panel Discussion—Handling, Feeding, and Testing of Fluorides .... *Led by* W. L. Harris, Sidney DeBoer, Norman Ellis, Howard W. Greene, George Hazey, Walter Muhlitner, and Howard Rafter
Centralizing Instrumentation and Control for Water Plants ..... R. S. Dark
Panel Discussion—Labor-saving Devices in Water Supply ..... *Led by* Jake Rubbo, Ray M. Harwood, Harold Huntley, Albert Sabo, and Paul Stegeman
The Water Works Industry Looks Ahead ..... W. F. Shephard

Minnesota Section—September 1–5, 1953

Address of Welcome ..... *Mayor* Garnet Coulter
Response ..... George J. Schroepfer
Panel Discussion—Distribution System Records ..... *Led by* Carl A. Flack
Mains, Valves, and Hydrants ..... Harold M. Johnson
Service Connections ..... George F. LaRoche
Meters ..... F. M. White
Laboratory Tests, Chemicals, and Equipment for the Small Water Plant ..... R. D. Sawyer
Detection and Elimination of Possible Wartime Water Contaminants ..... Ross A. Thuma
Economics of Water Softening ..... A. S. Johnson
Mechanical-Joint Cast-Iron Pipe ..... Thomas F. Wolfe
The Winnipeg Aqueduct ..... Harold Shand
Panel Discussion—Cold Weather Operation of Distribution Systems ..... *Led by* M. D. Lubratovich
Hydrants ..... H. H. Behlmer
Thawing Frozen Services and Mains ..... Paul Buccowich Jr.
The Effect of Cold Weather on the Water Distribution System ..... W. L. Wardrop
The Water Works Industry Looks at Fluoridation ..... A. E. Berry

Missouri Section—September 27–29, 1953

Panel Discussion—Importance of National Water Policy
The History of National Water Policy ..... W. W. Horner
The Effect of National Water Policy on Water Supply and Stream Sanitation ..... N. T. Veatch
The Effect of National Water Policy on Missouri Water Resources ..... E. L. Clark
Diesel Engines for Water Works Service ..... Glenn C. Boyer
Air Controls and Instrumentation for Water Plants ..... R. H. Babcock
Public Relations Panel ..... *Led by* E. L. Filby
Getting Your Story Before the Public Through Newspaper and Radio .... Charles Carter
The Employee as a Catalyst in Creating and Maintaining Good Public Relations ..... L. S. McArthur
The Sparking Points in a Public Relations Program ..... Lawrence E. Martin
Public Officials Don't Wear Horns ..... Vernie Crandall
The 1952 Drought and Its Effect on Water Systems in Missouri
The Weather ..... J. L. Jacobson
The Kansas City Story ..... M. P. Hatcher
The Bowling Green Story ..... Burke Schuster
Hydrology in Water and Sewerage Engineering ..... Stifel W. Jens
Elements of Stream Pollution Biology ..... W. W. Hatfield

Developments in Standards for Water Plant and System Design ..... O. E. Brownell
Fluoridation ..... *Led by* Garvin H. Dyer
The Case for ..... Paul F. O'Brien
The Case Against ..... W. T. Schrenk
Modernizing and Expanding Existing Water Treatment Plants and Pumping Stations
The St. Louis County Plant ..... H. O. Hartung
The City of St. Louis Water Plants ..... E. E. Easterday
Shall We Clean Our Well or Drill a New One? ..... Dick Joslyn
Can a Small Town Afford a Water System? ..... William B. Owen
Panel Discussion—Stabilization of Missouri River Channel and Its Relation to Existing Improvements ..... *Led by* C. R. Van Orman
The St. Charles Problem ..... Walter Oelklaus
The St. Joseph Problem ..... Frank J. McAndrew

Montana Section—April 24–25, 1953

Chairman's Address ..... A. L. Johnson
Round Table Discussion ..... *Led by* John Morrison and Chet Eyer
The Outlook for the Water Works Industry ..... Charles H. Capen
Nitrates in Drinking Water ..... C. W. Brinck
Present Trends in Water Works Construction ..... Thomas B. Robinson

Nebraska Section—April 16–17, 1953

Address of Welcome ..... *Mayor* Victor E. Anderson
Response ..... Harry L. Morris
Midwest Power Pool and Its Operation ..... Clarence Minard
Dependence of Lincoln's Well Supply Upon the Platte River ..... E. Bruce Meier
Water Transmissibility of Underground Gravels in Lincoln's Well Field .. Alden S. Metcalf
Defense and Our Utilities ..... Morrison B. Cunningham
Deep Well Turbine Pumps ..... Bert Gurney
Stream Pollution Legislation and Sewer Service Charges ..... D. R. Hill
Panel Discussion—Utility Costs Experienced in Highway Changes .. *Led by* John W. Cramer
Electric Utilities ..... Glen Walker
Gas Utilities ..... G. G. Holmes

New Jersey Section—October 22–24, 1953

Planning and Producing Slide Presentations ..... A. L. Terlouw
Water Works Operation as Affected by Sewage and Waste Disposal Practices ..... Robert J. Budrick
New Developments Forum
Membrane Filters ..... John Spooner
Materials Handling in the Water Works Plant ..... O. S. Carliss
Plastic Pipe ..... Herbert Eaton
Usage Control of Industrial Process Water ..... C. K. Banks
Wrigglers in Public Water Supplies ..... Thurlow C. Nelson
Report Research Coordination Committee ..... P. E. Pallo
Maintaining Well Production by Chemical Cleaning ..... E. Gordon Linn
Panel Discussion—Well Rehabilitation Works ..... *Led by* R. M. Leggette
Chlorination ..... A. E. Griffin
Calgon Treatment ..... Jack A. Adams
Acid Cleaning ..... Grover C. Mullin
Discussion ..... Virgil Every and August C. Schultes Jr.
Superintendents' Round Table Discussion ..... *Led by* Roy Evans

New York Section—April 16–17, 1953

Address of Welcome ..... *Mayor* Emory Strachen
Field Surveys—A Prerequisite for Efficient Operation and Design of Distribution Systems .. Charles J. Knoener
Metallizing ..... Howard Vanderpool
A Report on New York State Comptroller's Committee on Water Resources ..... James C. Harding
Round Table Conference ..... *Led by* S. P. Carman

New York Section—September 9–11, 1953

Address of Welcome ..... *Mayor* George C. Owens
Diatomaceous Earth Filters ..... Gilbert V. Levin and James K. Fraser
Deep Well Pumps ..... Allan W. Ross
Round Table Conference ..... *Led by* S. P. Carman

North Carolina Section—November 9–11, 1953

Historical Development of the High Point Water Supply ..... W. F. Freeman
Symposium—Water Supply ..... *Led by* Charles Smallwood
Calculation of Storage Requirements for Water Supply ..... Charles Smallwood and D. N. Cote
Water Inventories as Related to Development ..... E. B. Rice
Use of Polluted Water Sources for Emergency Water Supplies ..... J. M. Jarrett
Progress Report on Stream Classification in North Carolina ..... E. C. Hubbard
Progress Report on Fluoridation Practices in North Carolina ..... Emil T. Chanlett
Progress Report on Industrial Waste Research in North Carolina ..... Nelson L. Nemerow

Ohio Section—September 10–11, 1953

Address of Welcome ..... *Mayor* Thomas A. Burke
Cross-Connection Control—Is It Worth While? ..... Earl S. Hoyt
New American Standards Association Specifications for Cast-Iron Pipe ... Thomas F. Wolfe
Development of Cleveland Water Improvement Program ..... Frank J. Schwemler
Basis of Design for Water System Improvements ..... J. W. Avery
Administrative Problems ..... Emil J. Crown
Installation and Maintenance—Valves and Hydrants ..... F. H. Connors
Extending Water Service to Fringe Areas ..... Pierce Bailey
Experience in the Use of Sulfur Compound Jointing Material ..... Leo V. Garrity
Water Quality Criteria as Related to Municipal Water Supplies ..... W. W. Towne
Fire Protection Requirements ..... Harry L. Krieger
Use of the Membrane Filter in Routine Water Analysis ..... Elizabeth Collet
Toledo's Plans for Stabilization of the Public Water Supply ..... Richard R. Henderson
The Challenge of Taste and Odor Control ..... Kenneth W. Cosens
Panel Discussion—Problems in Cold-Water Softening Plants ..... Merrill L. Riehl, Robert Shoup, George Swanger, and J. Howard Bass
Standard Methods for Water Examination ..... Waldron D. Sheets
Experience Panel on Water Rate Adjustment ..... *Led by* E. F. Leist, Wendell R. LaDue, William A. Gaige, Robert B. Holt, and George J. Van Dorp

Pacific Northwest Section—April 16–18, 1953

Preparation of a Water Works Disaster Plan ..... E. J. Allen
Asphalt Reservoir Construction ..... John L. Geren
Discussion ..... H. L. Thompson
The Water Supply Problem in Korea ..... Reginald Bowering
High-Rate Filtration ..... A. H. Rice
Discussion ..... W. R. Conley Jr.

Panel Discussion—Highway Construction Over Existing Underground Utilities
The General Problem ..... G. A. Riedesel
The Municipality's Problem ..... Walter J. Moore and J. A. Kuehl
The Problem From the State Highway's Standpoint .....
W. P. Hughes, Val G. Rinehart, and W. C. Williams
Panel Discussion—Cavitation in Water Works Systems
Theory of Cavitation ..... W. W. Tinniswood
Solving a Field Cavitation Problem ..... W. A. Kunigk
National Water Policy Forum ..... *Led by* Robert E. Smylie,
Orland Mayer, W. A. Galbraith, Tom H. Judd, Roy W. Morse, and Marshall Dana
The Administrative Task of Influencing People ..... John M. Swarthout
Accident Prevention in Water Works Practice ..... Fred Jones
Water Charges Outside the City Limits ..... Mark Wrestling
The Portland Water Works System ..... George A. Marshall

Pennsylvania Section—June 17–19, 1953

Some Early Observations on the Operation of the New Filter Plant at Chester .....
Kenneth C. Armstrong
The Influence of Operating Data on Original Works on the Design of Extensions to Major Filter Plants:
At Richmond, Va. ..... Marsden C. Smith
At Trenton, N.J. ..... Lewis J. Klockner
Panel Discussion—How Should the Costs of Highway Relocation Be Met and by Whom? ..
Led by I. S. Sahli,
Ellwood H. Aldrich, J. G. Carns, and Charles F. LeeDecker
Recent Investigations on Ground Water Conditions in the Pittsburgh Area .. R. M. Leggette
Corrosion of Water Mains ..... John R. Baylis
Forestry and Watersheds ..... M. K. Goddard
Research and Experimentation in the Water Works Field .....
Martin E. Flentje and R. Rupert Kountz
The Development of an Ultrasonic Flowmeter ..... William B. Hess and R. C. Swengel
The Price Index—Past and Present-Day Costs in the Water Works Field ... Henry H. Fick

Rocky Mountain Section—September 21–23, 1953

Sewage Effluent Reclamation for Industrial and Irrigation Use .....
A. E. Greenberg and Jerome S. Thomas
Problems of Water Works in a Rapidly Expanding Community ..... Glenn E. Hands
Panel Discussion—Fluoridation of Public Water Supplies .....
Charles Wright and Charles G. Caldwell
Watershed Recreational Problems ..... Fred A. Thompson
Development of the Law of Underground Waters ..... Charles D. Harris
The Consulting Engineer's Contribution in Evaluating and Designing Municipal Facilities ..
William F. Turney
Location, Development, and Protection of Ground Water Supplies ..... R. C. Steele
Correlation Between the Civil Defense Command and the Municipal Water Works .....
D. H. McAnally

Southeastern Section—March 23–25, 1953

Meeting New Water Supply Problems in Newly Annexed Areas ..... Paul Weir
Mechanics of Installing Water Mains in Newly Annexed Areas ..... Roy Ruggles
Your Government and You ..... Mary D. Cain
Relocation of Water Mains on Highways Due to Construction .....
W. H. Weaver and Francis B. McDowell Jr.
Discussion ..... *Led by* John R. Bettis
Problems in Handling Manganese in Water Works Filters and Basins ..... Robert S. Ingols
Discussion ..... *Led by* Lowell Cady,
Clyde Angle and F. L. Futral

Public Relations ..... C. N. Wallace Jr.
Water Works Survey and Conservation—Panel Discussion ..... *Led by* William Hudson
Uprating Distribution System by Water Main Cleaning ..... J. A. Frank
Stream Pollution Problems ..... N. M. deJarnette
Fluoridation—Discussion ..... *Led by* Robert E. Stiemke, W. H. Weaver, H. L. Dooley, John T. Briscoe Jr., and John Pearson

Southwest Section—October 18–21, 1953

The Necessity for the Conservation of the Water Resources of Texas ..... A. P. Rollins
Legal Aspects of the Development of the Water Resources of Texas ..... Victor W. Bouldin
Panel Discussion—The San Jacinto River Water Supply for Houston
Brief History of Houston Water Works and Introduction of Subject .. Frank N. Baldwin
Basic Preliminary Investigation for the San Jacinto River Supply ..... G. L. Fugate
Design Features of Dam ..... M. A. Dillingham
Dam Construction Notes ..... Elmer Gardner
Design of Filtration Plant ..... N. P. Turner
Design Data on Dam Pumping Plant and Canals ..... Frank H. Newnam Jr.
The Finished Product ..... Clyde R. Harvill
Area Industrial Water Needs and Services to Be Provided by Proposed Supply ..... L. H. Earnest
Proposed and Future Water Distribution Mains in Vicinity of New Purification Plant .... W. K. Van Zandt
Panel Discussion—Meter Testing and Maintenance ..... *Led by* C. A. Sanders
Shop and Field Testing ..... Clyde M. Smith
Small-Town Metering Problems ..... J. S. Williams
Effect of Meter Sizes on Maintenance ..... V. R. Schmidt
Basic Safety Practices, Including Passenger Car and Truck Automotive Transportation .... J. U. Parker
Putting Zest Into the Safety Program ..... L. A. Martin
Guides for the Selection of Chemical Feeders ..... P. A. Coffman Jr.
Panel Discussion—Office Management—Its Methods and Their Value to the Water Works Superintendent ..... *Led by* Henry Wilkens Jr., O. Linguist, Marion R. Ulmer, and Harry E. Steenson
An Emergency S.O.P. ..... John D. Wedeman
The Dallas Water Emergency and What Was Done to Relieve It ..... Karl F. Hoefle
Increasing Water Resources in Texas—The Dallas Operation ..... Irving P. Krick

Virginia Section—November 4–6, 1953

Algae Control and Fish Life in Fresh-Water Reservoirs ..... Robert G. Martin
Virginia's Annual Short School for Water Works Personnel ..... Linvil G. Rich
Automatic Booster Stations ..... Charles E. Moore
Discussion ..... *Led by* L. A. Geupel
The Practical Application of E.T.S.-Chlorine to Air-Conditioning Water .... B. G. Switzer
Discussion ..... *Led by* J. P. Kavanagh
Newport News' Fifteen-Year Distribution Plan ..... H. E. Beckwith
Discussion ..... *Led by* W. B. Harman
Panel Discussion—Some Problems of Small Water Works ..... *Led by* W. Frank Chapman, A. K. Roop Jr., J. D. Rives, L. Z. Johnston Jr., J. A. McWhorter, F. F. Funk, R. L. Howe, and W. T. Wells
Panel Discussion—Cross Connections ..... *Led by* Linn H. Enslow, E. C. Meredith, Marsden C. Smith, and Kenneth J. Carl
Experience With Solids-Contact Clarifiers in Southeastern Virginia ..... Harry N. Lowe Jr. and Richard P. Schmitt
Water Supplies in Emergencies ..... H. P. Kramer

Panel Discussion—New Water Works in Virginia ..... *Led by* Richard Messer
Clarksville's New Plant ..... William F. Freeman
Emporia's New Plant ..... W. F. Middleton
South Hill's New Plant ..... Robert B. McNutt Jr.
Chesterfield County's New Plant ..... Warren C. Perrow
Chatham's New Plant ..... J. S. Carter

West Virginia Section—September 3–4, 1953

The Preparation and Use of Chlorine-activated Silica ..... A. E. Griffin
Maintenance and Repair of Water Meters ..... Russ Olsen and M. B. Stewart
The Advantages of Caustic Soda in the Treatment of Water Supplies .....
Dwight L. Jack, R. L. Henry, and M. E. Flentje
Municipal and Industrial Water Softening ..... Eskel Nordell
Panel Discussion—Water Well Cleaning
An Experience With Water Well Acidizing at Shrewsbury, W.Va. ..... H. W. Pitts
Water Well Cleaning With Calgon at Princeton, W.Va. ..... Nick Leshkow
A Pictorial Report on the Dental Health of Children Living in a Natural-Fluoride Area of West Virginia ..... James W. Ruble
Morgantown's Water Supply ..... H. W. Speiden

Wisconsin Section—September 22–24, 1953

Address of Welcome ..... Walter M. Swietlik
Washing and Maintenance of Filters ..... John R. Baylis
Taste and Odor Experiences ..... William U. Gallaher
Discussion ..... Bruno J. Hartman, Jerome Zufelt, Hubert J. Evers, and Gerald A. Rohlich
Summary of Ground Water Conditions in the Milwaukee-Waukesha Area .....
William J. Drescher
The Use of Polyphosphates for Well Cleaning and Iron Sequestration .... Lloyd L. Klinger
Discussion ..... Verne A. Somers, H. F. Weckwerth, and U. W. Baker
Installation, Maintenance, and Repair of Hydrants ..... William Hammann
The Economic Selection and Replacement of Pumping Equipment ..... O. J. Knechtges
Discussion ..... Arno T. Lenz and E. J. Duszynski
Procedures for Preparing Depreciation Schedules ..... A. R. Colbert
Office Records for Tomorrow ..... J. A. Hammes
Discussion ..... P. A. Reynolds and William Snell

Section Meetings—1949–1953

Section	*1949*	*1950*	*1951*	*1952*	*1953*	*Meeting Place—1953*
Alabama-Mississippi	Oct. 19–21	Oct. 11–13	Sept. 24–26	Nov. 16–19	Oct. 4–7	Jackson, Miss.
Arizona	Apr. 1–3	Mar. 31–Apr. 2	Mar. 28–31	Apr. 3–5	Apr. 16–18	Chandler, Ariz.
	Nov. 11–13	Nov. 30–Dec. 2	——	——	——	——
California	Apr. 29*	Apr. 21*	Apr. 6*	Apr. 17–19*	——	——
	Oct. 25–28	Oct. 24–27	Oct. 23–26	Oct. 28–31	Oct. 27–30	San Francisco, Calif.
Canadian	Apr. 25–27	Apr. 3–5	May 21–23	May 26–28	Apr. 6–8	Buffalo, N.Y.
	——	——	——	Oct. 21–22†	Sept. 21–22†	Amherst, N.S.
Chesapeake	Nov. 2–4	Nov. 1–3	Oct. 31–Nov. 2	Oct. 29–31	Oct. 28–30	Wilmington, Del.
Cuban	Dec. 1–3	Nov. 13–15	Nov. 29–Dec. 1	Dec. 4–6	Dec. 3–5	Havana, Cuba
Florida	Nov. 14–16	Nov. 13–15	Oct. 28–31	Nov. 16–19	Oct. 11–13	Miami, Fla.
Illinois	——	Apr. 12–14	Mar. 28–30	Mar. 26–28	Mar. 18–20	Chicago, Ill.
Indiana	Apr. 20–22	Apr. 26–28	Feb. 7–9	Feb. 13–15	Feb. 11–13	Indianapolis, Ind.
Iowa	Oct. 6–7	Oct. 26–27	Oct. 25–27	Oct. 23–25	Oct. 14–16	Waterloo, Iowa
Kansas	Apr. 21–22	Apr. 19–21	Apr. 11–13	May 3	Apr. 22–24	Wichita, Kan.
Kentucky-Tennessee	Oct. 31–Nov. 2	Oct. 23–25	Sept. 17–19	Sept. 15–17	Sept. 21–23	Owensboro, Ky.
Michigan	Sept. 28–30	Oct. 25–27	Sept. 19–21	Sept. 24–26	Sept. 3–4	Escanaba, Mich.
Minnesota	Sept. 8–9	Sept. 6–8	Sept. 12–14	Sept. 9–12	Sept. 1–5	Winnipeg, Man.
Missouri	Sept. 25–27	Oct. 1–3	Sept. 30–Oct. 2	Sept. 21–23	Sept. 27–29	Excelsior Springs, Mo.
Montana	Apr. 8–9	Apr. 21–22	Apr. 20–21	Apr. 11–12	Apr. 24–25	Kalispell, Mont.
Nebraska	Apr. 21–22	Apr. 13–14	Apr. 19–20	Apr. 17–18	Apr. 16–17	Lincoln, Neb.
New England	——	——	——	——	——	——
New Jersey	Feb. 17	Feb. 15	Feb. 14	Feb. 13	Feb. 17	Newark, N.J.
	June 23	——	June 29	June 25	June 17	Martinsville, N.J.
	Nov. 17–19	Oct. 26–28	Oct. 25–27	Oct. 23–25	Oct. 22–24	Atlantic City, N.J.
New York	Jan. 21	Jan. 17	Jan. 16	——	Jan. 20	New York, N.Y.
	Apr. 28–29	Mar. 30–31	Apr. 5–6	Apr. 17–18	Apr. 16–17	Elmira, N.Y.
	Sept. 6–7	Sept. 7–8	Sept. 13–14	Sept. 4–5	Sept. 9–11	Lake Placid, N.Y.
North Carolina	Nov. 7–9	Nov. 13–15	Nov. 12–14	Nov. 10–12	Nov. 9–11	High Point, N.C.
Ohio	Nov. 3–4	Sept. 28–29	Sept. 27–28	Sept. 18–19	Sept. 10–11	Cleveland, Ohio
Pacific Northwest	May 12–14	May 11–13	May 17–19	Apr. 24–26	Apr. 16–18	Portland, Ore.
Pennsylvania	Sept. 14–16	Oct. 18–20	Sept. 19–21	June 18–19	June 17–19	Hershey, Pa.
Rocky Mountain	Sept. 21–23	Sept. 27–29	Sept. 24–25	Sept. 15–17	Sept. 21–23	Santa Fe, N.M.
Southeastern	Dec. 5–7	Oct. 23–25	——	Mar. 24–26	Mar. 23–25	Macon, Ga.
Southwest	Oct. 10–12	Oct. 16–18	Oct. 14–17	Oct. 12–15	Oct. 18–21	Houston, Tex.
Virginia	Oct. 24–25	Nov. 6–7	Nov. 7–9	Nov. 5–7	Nov. 4–6	Roanoke, Va.
West Virginia	Sept. 22–23	Sept. 13–14	Oct. 4–5	Oct. 2–3	Sept. 3–4	Morgantown, W.Va.
Wisconsin	Oct. 11–13	Sept. 19–21	Sept. 25–27	Sept. 16–18	Sept. 22–24	Milwaukee, Wis.

* Regional meetings. † Maritime Branch.

Section Membership at Time of, and Total Attendance at, Section Meetings—1949–1953

SECTION	1949		1950		1951		1952		1953	
	Membership	Attendance	Membership	Attendance	Membership	Attendance	Membership	Attendance	Membership	Attendance
Alabama-Mississippi	164	140	167	141	163	181	169	400‖	177	182
Arizona§	69	181	83	93	72	154	71	173	72	41
California§	826	831	947	1,267	1,028	1,252	1,044	1,434	1084	1126
Canadian§	485	574	515	728	531	516	582	756	581	617
Chesapeake	209	196	245	149	247	119	241	250	247	224
Cuban	57	71	61	216‖	65	52	73	52	72	*
Florida	216	174	240	216‖	300	282	306	400‖	327	287
Illinois	450	†	459	284	470	348	475	418	482	407
Indiana	207	266	256	264	289	299	333	392	330	386
Iowa	102	138	109	242	115	195	119	182	121	178
Kansas	113	168	139	179	139	186	187	*	206	170
Kentucky-Tennessee	196	153	199	222	186	202	186	252	186	203
Michigan	254	211	284	214	294	225	319	242	349	164
Minnesota	182	169	208	177	216	167	230	179	229	166
Missouri	157	199	169	125	181	202	190	225	189	242
Montana	61	94	58	140	62	120	59	168	58	107
Nebraska	54	18	55	23	64	158	75	152	82	224
New England	187	†	192	†	205	†	211	†	218	†
New Jersey§	339	218	350	218	379	276	411	311	414	318
New York§	643	250	682	*	715	340	743	375	741	355
North Carolina	171	226	176	222	178	242	182	261	188	294
Ohio	380	308	382	321	392	320	400	297	403	252
Pacific Northwest	277	267	295	330	299	257	315	267	345	346
Pennsylvania	345	147	390	182	419	214	433	215	455	204
Rocky Mountain	147	86	145	126	141	128	157	122	156	125
Southeastern	152	161	170	152	181	‡	190	220	203	205
Southwest	659	618	678	795	702	708	779	582	938	803
Virginia	167	228	171	215	177	84	183	237	179	226
West Virginia	87	123	92	154	94	156	98	130	102	120
Wisconsin	143	301	150	290	164	305	176	314	181	288

* No record of attendance.
† No regular meeting scheduled. Membership given as of dates of conferences.
‡ Regular meeting cancelled. Business meeting held at annual conference.
§ Only one of section's meetings recorded here.
‖ Joint meeting.

Binding the Year's Journals

Through the cooperation of the Library Binding Institute, an organization of binderies which specializes in binding publications into volumes, arrangements have been made to give information and assistance to AWWA members who want to have their JOURNALS bound. This work may be done in accordance with standards of materials and construction required for durability, service, and accessibility by college, reference, and public libraries. The American Library Association and the Library Binding Institute have cooperated in promulgating "Minimum Specifications for Class A Library Binding" based on research and production and performance experience.

A committee of the American Library Association has certified responsible and reliable library binderies which have proved able to meet these specifications. To obtain standard quality binding, simply request Class A binding at any certified bindery. In obtaining price quotations, state the three dimensions of the volume.

Names and addresses of certified binderies in your area are available from the Library Binding Institute, 501 Fifth Avenue, New York 17, N.Y. Before sending copies to the bindery:

1. Check for missing issues and check each issue for defects, missing pages, etc. Be sure to include the volume index.

2. Tie the twelve issues together carefully so that nothing is crumpled or torn.

3. Write out definite instructions giving your preferences on the following points:

a. Color of binding (one of the following standard colors should be selected: dark green, dark blue, black, brown, or medium red).

b. Whether the advertising sections and/or paper covers are to be bound into the volume.

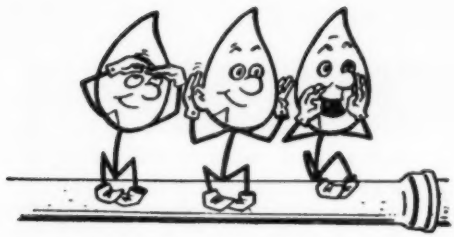
c. An exact copy of the text to be lettered in gold on the backbone. A common form is:

Journal—1⅜ in. from top	Vol. 45—4¼ in. from bottom
AWWA—2¼ in. from top	1953—3⅜ in. from bottom

d. If you have had JOURNALS bound before and want your set to match as closely as possible, send a previous volume as a sample. If you want an approximate match, send a "rubbing" of the lettering on a previous volume and indicate the color.

If satisfactory arrangements cannot be made, or if there is any difficulty, advise the AWWA office and steps will be taken in cooperation with the Library Binding Institute to assure you proper service.

By arrangement with AWWA, University Microfilms, 313 N. First St., Ann Arbor, Mich., is making a microfilm edition of the JOURNAL available to regular subscribers at a price comparable with the cost of library binding. The cost of the 1952 volume was $7.95.



Percolation and Runoff

Quarantine is customarily lifted at this time of year to let all those stricken with acute contributionitis out into the open for the Christmas holidays—one respect, at least, in which the regimen of Editors Anonymous has been a little laxer than that of that other organization distinguished by its anonymosity. The letdown, of course, can't be considered too surprising in view of the fact that Editors Anonymous has always measured its success rather than its failure by the number of its returnees. Thus, in this year's disanonymization of those who did P&R's dirty work, we haven't been above hinting—and rather broadly—at the number of years of recognized seizure suffered by each anonym.

To the unedified, we need perhaps explain that Editors Anonymous has now been in business for six long years, containing those who have developed such a taste, or even craving, for P&R that they have contributed the clippings and incredibilia that are its raw material. Those whose scissoring seizures have been both strong and persistent have been diagnosed *Incurable*—a state rarely attained at first exposure, as it was this year by a Texan. When the attack rate is on the borderline between chronic and recurrent, the diagnosis is *Deetees*—also uneasy of attainment in one swell foop. The *Shakes* are a little less frequent in their indulgence, and the *Jitters* only occasional and sometimes even unaware. All these together are responsible for that frequent state of nonsensibility that characterizes these columns, and we who merely minister to their seizures wish them more—or should we say higher—power. These, then, be they:

Incurables

C. H. Capen[5]
E. L. Filby[6]
R. E. Hansen[2]
G. E. Symons[4]
J. M. Wafer[6]
Henry Wilkens
D. B. Williams[3]
P. S. Wilson[6]

Deetees

R. L. Jones[6]
W. R. LaDue[3]
M. J. Harper
W. V. Weir[4]

Shakes

N. M. DeJarnette[3]
J. M. Diven[4]
Rolf Eliassen[5]
Hugh Kellner[2]

Jitters

L. E. Blakely
J. R. Brown[3]
O. W. Carrick
J. A. Coleman
D. M. Dimmers
C. F. Drake[2]
M. E. Flentje[2]
J. L. Ford
R. V. Ford
N. J. Goode
R. L. Heck
L. R. Howson
W. T. Ingram
W. B. Kirchman
T. J. Lafreniere
H. E. Lordley
Leo Louis
Malcolm Merritt
C. E. Painter
W. S. Pardoe
B. E. Payne
Jack Service[2]
G. R. Scott
E. A. Sigworth[5]
L. N. Thompson
C. B. Tygert
J. E. Vogt
W. A. Welch[2]

To all these, Merry Christmas and Happy Relapse! To all who may have been similarly tempted, Merry Christmas and Happy Lapse! To all, Merry Christmas!

(Continued on page 30 P&R)

(Continued from page 29 P&R)

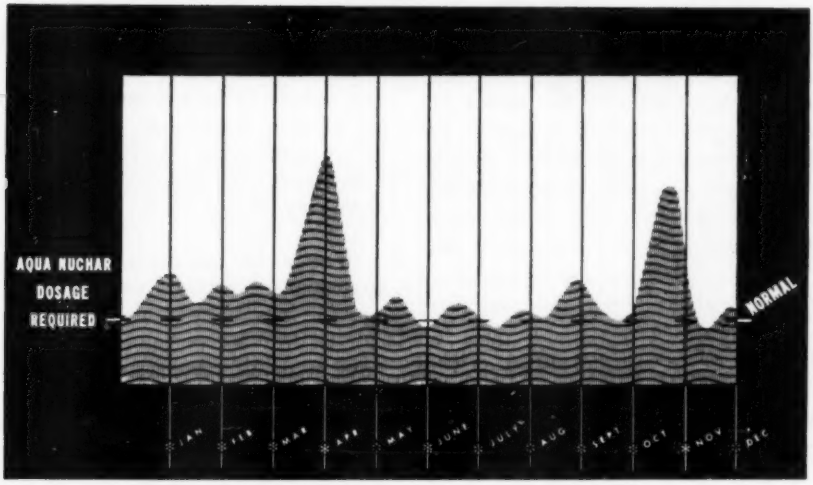
Water in politics these days seems to be stirring up more widespread excitement than politics in water has ever been able to muster—so much, in fact, that it has been getting the same kind of bi- or un- or nonpartisan attention that foreign policy has at times seemed to rate. Thus, in the campaign just past, candidates for almost everything almost everywhere spoke up strongly for more and better water, however leaky their suggestions for financing it may have been. Not party at all, but lungpower most often determined which side spoke loudest for whatever water supply project promised to be most popular. All of which elevated water works men almost to the level of babies in the affections of the votogenic.

Particularly in New Jersey was water supply prominent in every platform, from that of village council candidates to that of the gubernatorial aspirants. And though it was clearly not water in which Republican hopes sank there, Governor-elect Meyner did manage to add volume to his water works with a call for a bigger share of the Delaware than his opponents had been willing to accept under a projected interstate agreement. In New York State, too, with another drought busy bottoms-ing-up reservoir after reservoir and drying down well after well, every campaign was virtually waterlogged, taphappy candidates going after every drop from the clouds to the Canadian border. Even specifically, water supply was an issue, involved in two of the nine constitutional amendments which appeared on the statewide ballot. Approval of the first of these lets Legislature: authorize borrowing by municipalities to develop supplies of water in excess of their own needs for sales to other public corporations and improvement districts; and authorize borrowing by public corporations and improvement districts, jointly or in specific proportions, to provide for a common supply of water. Approval of the second, unfortunately, will bar any further river regulation in the Adirondack and Catskill Mountain state preserves unless separate constitutional amendments for each project are adopted, but, there, water wasn't deep enough in the politics, permitting wildlifers to confuse the issue to the extent that even the usually thoughtful New York *Times* took the side of the trout fisherman against that of the flood controller and the water supply developer.

All this is not to suggest that politics in water is any less exciting than it ever was, but it seems not too unlikely that the more water is in politics, the less politics will be in water. At any rate, where the people get interested enough in the issue to make their politicians realize that it is one, there seems real promise that a first step has been taken toward public demand for an efficient administrative set-up—carrying the bi- or un- or nonpartisanship to its reasonable conclusion.

"*'Tis the season to be jolly. . . .*"

(Continued on page 32 P&R)



PEAKS DON'T COUNT in your carbon budget

Whenever taste and odor increase in your water supply it is necessary to use more Aqua Nuchar Activated Carbon. Don't blame the Aqua Nuchar if your dosages are insufficient because it is always the same quality and will adsorb with its usual speed the objectionable algae and trade waste tastes and odors. In addition, constant dosages of Aqua Nuchar will serve as the foundation for a quick increase should a greater requirement arise. However, it must be remembered that when these sudden intensifications in taste are cured and required dosages fall back to normal, the amount of *extra* Aqua Nuchar added must be eliminated.

To show your water plant operators and superintendents the exact amounts of Aqua Nuchar Activated Carbon required, our experts from our Technical Service Department will give a complete Threshold Odor Survey without obligation. Furthermore, they will advise them how to use Aqua Nuchar Activated Carbon with other chemicals. To obtain the palatable water your consumers desire, Industrial is ready to assist.

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At Shaker Square
Cleveland 20, Ohio

(Continued from page 30 P&R)

A snap to make water conservation automatic during shortages has been incorporated into a valve device invented by Wilfred C. Swanker of the Cleveland engineering firm of Grothe & Swanker, Inc. The unit, which has been offered royalty-free to the city of Cleveland, is designed for wire-sealing to home sill cocks, where it would cut off the flow to hoses and sprinklers whenever the area's water pressure dropped to a predetermined critical level, and then snap open again when normal pressure was restored. The seal, of course, is the trap on the tap snap that gives it teeth.

Offered for sale is a complete water utility, the Lake Tamarack Water Co., serving a community of approximately 200 homes in Sussex County, N.J. The system includes four wells and two storage tanks. Most of the distribution system is buried below frost line for all-year operation. Inquiries are being received by M. Roger Harden, Treasurer, Lake Tamarack Water Co., Hamburg, N.J.

Seattle Ho means lots of dough, particularly for travel expense. Thus, word of a new Internal Revenue Bureau ruling that permits all taxpayers now to deduct their convention costs as business expenses is mighty good news from a usually revilable source. Credit for the new credit goes to one Rita Callinan, a Buffalo law firm secretary who deducted a $400 expense of a secretaries' convention in California on her 1948 return and then fought the Bureau for five years to win her point. Make your reservations now!

(Continued on page 34 P&R)

LIMITORQUE
VALVE CONTROLS

From coast to coast, hundreds of LimiTorque Controls are in service in water works and sewage disposal plants for automatic or push-button operation of valves up to 120 inch diameter. Why is acceptance so widespread? Because LimiTorque Operators are designed to provide depend ble, safe and sure valve actuation at all times.

LimiTorque is self-contained and is applicable to all makes of valves. Any available power source may be used to actuate the operator: Electricity, water, air, oil, gas, etc.

A feature of LimiTorque is the torque limit switch which controls the closing thrust on the valve stem and prevents damage to valve operating parts.

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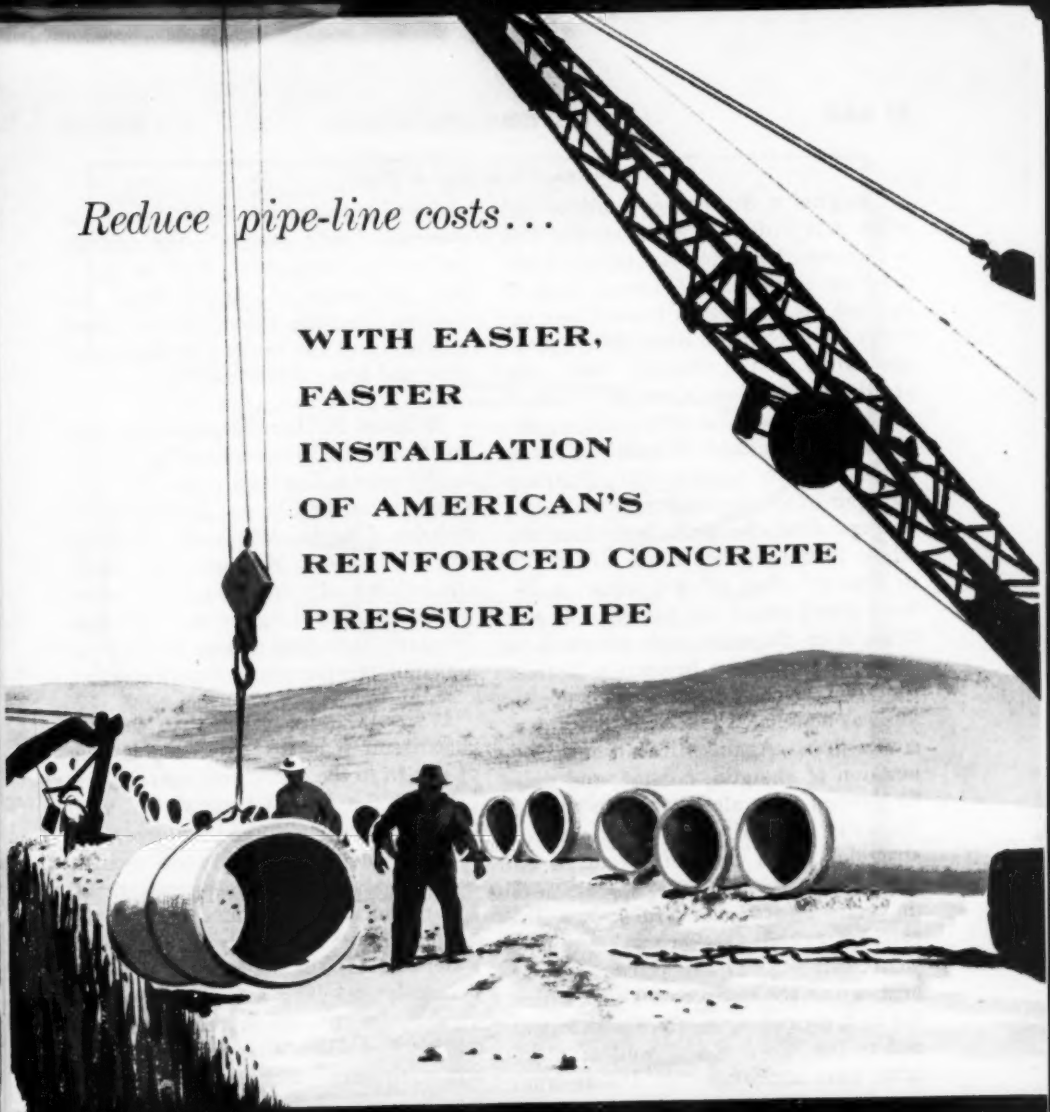

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Excavation costs are lower. No need for bell holes or excessive trench width. Flexible joints allow for minor changes in grade or alignment . . . offer protection against normal earth settlement.

Contractors can use standard equipment and semi-skilled labor to lay reinforced concrete pipe. Joint closure is simple and economical. Rubber gasket joints provide a safe, positive closure and eliminate costly welding or caulking.

Immediate backfilling is recommended and eliminates open trench hazards and costly, worrisome traffic problems.

You can realize these savings in installation costs and substantially reduce over-all pipe-line costs.

At the same time, the superior design, materials and workmanship which reflect American's 45 years of specialized experience in this field assure you of highest quality and maximum performance.

Write or call today for complete information.

American PIPE AND CONSTRUCTION CO.

Concrete pipe for main water supply lines, storm and sanitary sewers, subaqueous pipe lines

P. O. Box 3428, Terminal Annex, Los Angeles 54

Main Offices and Plant: 8635 Firestone Blvd., South Gate, California LOgan 8-2271

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(Continued from page 32 P&R)

Tougher'n Suffern is hard to get when it is Suffern's water supply that is threatened. Thus, last month when the New York State Thruway Authority took its first steps toward moving the polluted Ramapo River within seepage range of the village's three new artesian wells, thereby to get it out of the way of the New York-Albany superhighway, village officials pulled no punches. No sooner had Thruway men put in an appearance to make test borings near the well field than the whole Suffern police force turned out to "escort" then off the scene; a 24-hour armed guard was posted; suit was brought in the state supreme court to obtain a permanent injunction against the river relocation; and public opinion was marshaled to the cause of thirst comes first. Against this all-out combination of shotgun, lawsuit, and public protest, the already battle-scarred Thruway Authority had little taste for struggle. So a crew of seventeen officials from its own staff and that of the state attorney general's was dispatched to the Suffernots to make peace, offering: (1) to place a permanent cap on the reserve well over which the new course of the river was to run and to put down a new well near the other two, approximately 100 ft from the river; (2) to pave about a mile of the new course of the river from a point 4,000 ft upstream of the wells to prevent their pollution by seepage of the river water; and (3) to maintain the paved portion of the stream forever at no cost to the village. Thus appeased and pleased, the village officials were, at last reports, ready to accept the solution if their own engineers and chemists were willing to accept the capitulation.

That tough, unfortunately, isn't easy for water works men to get when it's only a distribution system to be moved at the pleasure of the highwaymen, for then it's "only money"—the utility's and/or the taxpayer's—that's at stake. But, borrowing a slogan from the United Hospital Fund, "Give Them Health," and you really give them hell-plus, and leave them helpless.

William P. Haendel, formerly sales representative for Neptune Meter Co. in Wisconsin, has been appointed sales manager for the Chicago district, which includes Illinois, Minnesota, Wisconsin, the Dakotas, Michigan, and northern Indiana. He has been in the water works equipment field for more than 30 years, including almost 10 years as a manufacturing plant superintendent.

It's soft soup rather than the expected soft soap that has been issuing of late from the public relations department of the Dow Chemical Co. with the issuance of a special feature tying in soft water with tasty soup recipes. Sent to some 1,700 newspapers and 500 radio homemaking editors all over the country, but particularly in the hard-water states, the feature is directed primarily at selling soft water, though incidentally, of course, enlarging the market for Dow softening chemicals and equipment. Skipping the inconsequentials from beef suet to onions and leeks, we give you "End-o'-the-garden Soup (for freezing or canning)":

"In canning by the water-bath method, be sure to use soft water in the processing kettle to avoid the unpleasant scum which adheres to the jars when hard water is used during the boiling period. Soft water will also prevent a blackened inside aluminum kettle.

"Use of soft water is one of the tricks of commercial canners that is not common knowledge to the homemaker."

Peas porridge hard, peas porridge soft. . . .

(Continued on page 36 P&R)

BOARD OF PUBLIC AFFAIRS
MILLERSBURG, OHIO

June 24, 1953

Simplex Valve & Meter Co.
Philadelphia 42, Pa.

Gentlemen:

We have acquired a Simplex Venturi main line meter from the City of Wooster, Ohio. This meter was sold to City of Wooster on May 4, 1912.

We plan to install this meter on our main line at Millersburg, Ohio Water Plant. Will you please send me descriptive information and parts list for this meter.

Markings on identification plate are as follows:
8" Tube 4" Throat #8-43-548-G.D. MSD 38.187
May 4, 1912 Markings on Cover Plate #546

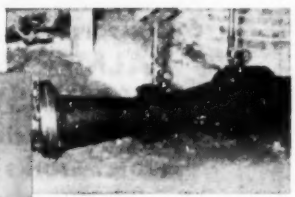
Address reply to: C. R. Deitrich, Supt. of W.W.

Respectfully,

C. R. Deitrich

C. R. Deitrich

Another proof that
Simplex is reliable in the long run!



Simplex Meter and Venturi Tube recently installed after service of over 40 years!

For details, write: Simplex Valve & Meter Company, 6784 Upland Street, Philadelphia 42, Penna.

SIMPLEX®
VALVE AND METER COMPANY

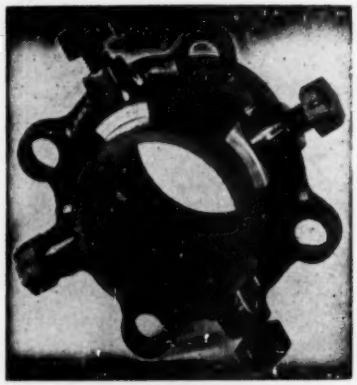
(Continued from page 34 P&R)

Willard F. Rockwell resigned in September as assistant to Secretary of Defense Charles E. Wilson and has returned to Rockwell Mfg. Co., of which he is chairman of the board. Originally assigned to Mutual Security Agency when he joined the Administration earlier this year (see March P&R, p. 44), Col. Rockwell helped evaluate American aid abroad as assistant to MSA Director Harold Stassen. He joined the Defense Dept. April 1 and worked first on reorganizing the Army and Navy Munitions Board into the new Office of the Assistant Secretary for Supply and Logistics. Later he went to Paris to confer with NATO groups on munitions procurement, and then spent three weeks inspecting munitions supply sources in NATO countries.

Marlow Pumps of Ridgewood, N.J., maker of self-priming centrifugal pumps, has merged with Bell & Gossett Co., Morton Grove, Ill., which makes hot water circulating pumps, flow control valves, and other heating specialties. The merger involves a pooling of resources and facilities, but both product lines will retain their individuality.

A M Rawn, chief engineer and general manager of the Los Angeles County Sanitation Dist., has been elected chairman of the California State Water Pollution Control Board, on which he has served since the organization of the board in 1949. He succeeds Warren T. Hannum, retired State Director of Natural Resources.

(Continued on page 38 P&R)



ANCHORED CLAMP for MECHANICAL JOINTS

Also CI-60 charcoal cast iron bolts for mechanical joints; ball-joint Leak Clamps and Gasket Sealer Compound.

Write for information

H. Y. CARSON COMPANY
1221 Pinson St. Birmingham, Ala.

6 Reasons why
PALMER SURFACE WASH SYSTEMS
are specified by water works engineers

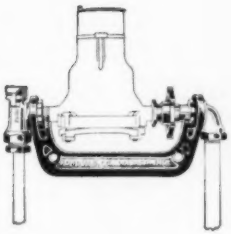
1. Prevent Sand Beds From Cracking.
2. Eliminate Mud Balls.
3. Save Wash Water.
4. Lengthen Filter Runs.
5. Higher Rates of Filtration.
6. Better Tasting Water.

Write today for Bulletin 451 and a list of water purification plants that have gone modern.

STUART CORPORATION
516 N. CHARLES ST., BALTIMORE 1, MD.

a Ford Yoke

for EVERY SETTING



Ford Yokes are made in styles to meet every meter setting condition—indoors or out. Regardless of location, the Ford Yoke makes settings easier, removes pipe strains, saves labor and keeps meter connections permanently aligned for fast changes. Roughly, Ford Yokes are made in three styles:

1. Riser Yokes, to use where the meter must be raised above the service line.
2. Angle Yokes, to satisfy a vertical inlet, horizontal outlet condition.
3. Straight Line Yokes, for setting meters in a horizontal line without raising the level of the meter.

Every Ford Yoke is permanently satisfactory. Send for full information.

FOR BETTER WATER SERVICES **FORD**

THE FORD METER BOX COMPANY, INC. Wabash, Indiana

(*Continued from page 36 P&R*)

Plenty of drought about it these days—the U.S., we mean, and particularly the Northeast—and the headaches it has been giving water works men have been only part of the story. Autumn itself took a beating, a good many of the leaves of New York and New England skipping their usual colorama for a dull brown and a quick drop. Hunting seasons were postponed, this time to save the forests rather than their inhabitants; and in Rhode Island even freshwater fishing had to be suspended when the waters left became so crowded that fish could be scooped out in pail or basket. Bears, dried out of their normal diet, took to foraging in civilized kitchens and garbage pails, colleges were closed when just plain thirst overcame the thirst for knowledge, football fields became too hard to play on, and hydrants ran dry, necessitating emergency firefighting supplies. But in New Jersey, birdwatchers were tickled just pink, when the drought drove golden plovers, yellowlegs, dowitchers, turnstones, egrets, herons, terns, and many unusual species of sandpipers from their usual inaccessible haunts to the shallowing reservoirs. And out in Horse Cave, Ky., Horsecavians were busy praying that it wouldn't rain, drought-stricken though they were, because someone left 45,000 unwanted gallons of arsenic trichloride dripping on a railroad siding ready to gas the community into unlivableness if combined with water. It is an ill wind all right, but we'll take sparrows and lend Horse Cave our umbrella if it will only make with the moisture before we have to ride New York's subways during another binge of bathlessness.

Hold tight is our advice to California Section Chairman Goit, hanging on to the right side of the Old Oaken Bucket above, for though Morrison Cunningham is posing there as AWWA President, you can be quite sure that he hasn't forgotten that he's a Southwest Sectioneer, and the feel of that prize is going to make him that much more anxious to be its custodian one of these days. Soon, too, he'll vow, for the picture, taken at the recent San Francisco meeting of what is now AWWA's largest section, doesn't do justice to the steady Southwestward pressure that has been exerted on the bucket over the past year. And though

October's jump of 74 members still left the Southwest 133 short of California's 1,074, it isn't going to take many months of gaining at this rate to break the 13-year monopoly that has kept the prize on the lower West Coast ever since it was established in 1939. Of course, "California, here we come" may find California on its way, too—onward and upward toward its second thousand. To "hold tight," in other words, may mean to let go with both barrels!

(*Continued on page 40 P&R*)

NO NEED
to specify over-sized pipe . . .
NO WORRY
over low flow capacity . . .
NO NEED
to buy bigger and bigger pumps . . .

. . . when you protect pipe lines with BITUMASTIC® 70-B ENAMEL

Pipe lines don't "shrink" when the interior surfaces are coated with a spun lining of Bitumastic 70-B Enamel . . . because this durable enamel *prevents* rust, corrosion, incrustation and tuberculation.

When the inside diameter of your pipe line *stays* the same through the years, you select pipe solely on the basis of desired capacity. You don't waste money by specifying *over-sized* pipe in order to allow for future "shrinkage." When your pipe line's coefficient of flow *stays* high, you don't have to replace pumps with bigger ones that cost more to buy and operate.

Bitumastic 70-B Enamel is equally effective in protecting exterior surfaces of pipe lines. It prevents pitting and leakage caused by soil corrosion. Give your steel pipe lines *lasting* protection, inside and out, with Bitumastic 70-B Enamel. Write for details.

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District Offices: Boston, Chicago, Los Angeles, New York, Pittsburgh, and Woodward, Alabama

(Continued from page 38 P&R)

Scotland G. Highland, who retired as superintendent and general manager of the Clarksburg, W.Va., Water Board earlier this year, died on October 25 at the age of 74. He had served the board for 44 years, and was its general manager for all but the first three.

Donald B. Williams, who has been in charge of purification at the Brantford, Ont., water works laboratory, has crossed the border to come to Ottumwa, Iowa, where he will be in charge of treatment for the water works.

A new Ring-Tite coupling has been developed by Johns-Manville for its Transite asbestos-cement pipe. The new coupling (see cut) involves a redesign of the basic sleeve and two rubber rings comprising the hitherto standard Simplex coupling, and is said to speed and simplify installation. Grooves cut in the inner wall of the sleeve position the rubber rings accurately, automatically centering the pipe ends and allowing room between them for expansion. The shaped contours of the pipe ends permit easier insertion through tapering and a shoulder which acts as a stop as the ring slides along the surface.

Russell Suter, who retired in 1948 as executive engineer for the New York State Water Power and Control Commission, died during the month of October. He had been serving as consultant to the New York City Board of Water Supply on its Delaware project.

(Continued on page 42 P&R)

AA QUALITY
THE AMERICAN AGRICULTURAL CHEMICAL COMPANY

For Public Water Fluoridation

Sodium Silicofluoride—98%
(Dense Powder)

Sodium Fluoride—98%
(Dense Powder or Granular)

Meets AWWA specifications

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Minimum of dust in handling
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Available in bags and drums

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Modernization with Rensselaer

The Old Port Washington, Wisconsin, Water plant is now one of the most modern filter plants in the country.

The illustration shows the pump room, entirely equipped with Rensselaer gate and check valves. All gate valves 4 inch and larger in the entire plant are also Rensselaer.

Rensselaer products are well above specifications not only in general characteristics but in the thickness of metal at important points. They are designed with the "know how" which goes back to the early days of water systems, and they are built by technicians many of whom have been with the Company 35 years or more.

You don't have to build a new plant in order to modernize with Rensselaer. Ask our local representative why a replacement of a troublesome check valve will eliminate slam—why Rensselaer tapping sleeves save time, and why Rensselaer hydrants and valves will save maintenance on your service extensions.

Rensselaer VALVE COMPANY, TROY, N. Y.

GATE VALVES • FIRE HYDRANTS • SQUARE BOTTOM VALVES • CHECK VALVES • AIR RELEASE VALVES

SALES REPRESENTATIVES IN PRINCIPAL CITIES

101

(Continued from page 40 P&R)

Subverse, not verse at all, are these lines which appeared in the latest issue of the Philadelphia Suburban Water Co.'s *Voice:*

Pure water is the best of gifts that man
to man can bring,
But who am I that I should have the best
of anything?
Let princes revel at the pump, let peers
with ponds make free,
Whiskey, or wine, or even beer is good
enough for me.

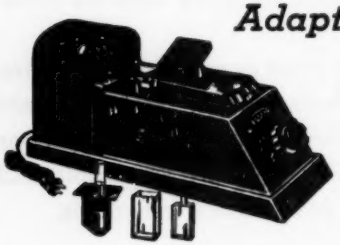
As a matter of fact, we'd say not even *Voice* at all, but sub*Voice,* were it not for the fact that the lines were actually printed as a part of a contribution of a celebrated columnist customer, and even he wouldn't admit to having written them.

Progress, which has during the past 83 years brought us such wonders as 3-D, TV, DDT, Krilium, chlorophyll, rainmaking, and the king-size cigarette, not to mention jet planes, the A-bomb, and Marilyn Monroe, seems almost to have passed Arkansas City, Kan., by. At any rate, the agenda for this year's commission meetings were still carrying exactly the same major items as did those of the first town meeting back in 1870: stray dogs, municipal revenue, and water supply. Come to think of it, though, there isn't anything really old-fashioned about a $300,000 price tag on a water supply expansion project for a town of 12,903. As a matter of fact, that sounds way ahead of most of us.

Hammond Iron Works has just completed a modern fabricating plant outside of Birmingham, Ala., to handle its line of steel tanks and steel plate construction. Four other Hammond plants are located in Pennsylvania, Utah, and Wyoming.

KLETT SUMMERSON
ELECTRIC PHOTOMETER

Adaptable for Use in Water Analysis



Can be used for any determination in which color or turbidity can be developed in proportion to substance to be determined

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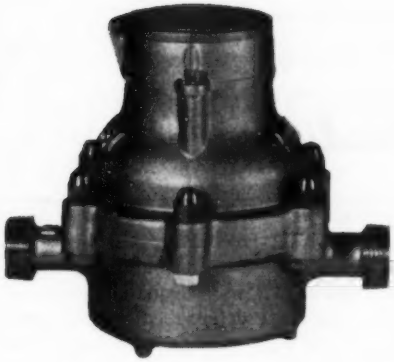

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There are no substitutes for HERSEY WATER METERS

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MODEL HF

Particularly designed for use in areas where freezing conditions may be encountered

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SOUTH BOSTON, MASS.

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SAN FRANCISCO LOS ANGELES

The Reading Meter

Water Resources of the Rochester Area, New York. *I. G. Grossman & L. B. Yarger. Circular 246, Geological Survey, Washington 25, D.C. (1953) 30 pp.; paperbound; free*

Despite the gift of Lake Ontario lapping at its front door, Rochester uses streams, lakes, and some ground water in addition to tapping the baby of the Great Lakes. So long as the lake is there, however, Rochester's problems tend to be described in terms of greatest economy rather than desperate necessity.

Operation and Repair of Water Facilities in Civil Defense Emergencies. *United States Civil Defense Technical Manual TM 13-2, Federal Civil Defense Administration (1953) 63 pp.; paperbound; available from state or local civil defense offices, or 25¢ from Government Printing Office, Washington 25, D.C.*

"If we are prepared we can come back fighting" is the slogan offered by the Federal Civil Defense Administration, and this booklet is a primer for that preparation. It should be observed, for the benefit of the inevitable person who will not bestir himself because he doubts the reality of the need, that the need can take many forms, and that many of the precautions and preparations suggested by this manual, including the mutual aid arrangement, are as useful against windstorm, earthquake, explosion, or conflagration as they are against enemy action. Indeed, such housecleaning tasks as the preparation of adequate distribution system records are helpful and necessary to every-day operations. The converse of this proposition is unfortunately not true, however, and the best run of utilities is not adequately prepared for a true civil defense emergency unless the contents of this booklet have been mastered and its recommendations—whether for personnel training, procurement of special equipment, or knowledge of treatment measures effective against biological warfare—are carefully absorbed.

Estimating Construction Costs. *R. L. Peurifoy. McGraw-Hill Book Co., New York (1953) 315 pp.; $7.50*

This excellently detailed volume offers much concrete information on quantities of materials and labor power required for various jobs of engineering construction. By presenting his findings largely in such basic terms rather than translating them all into dollars, the author avoids the difficulties posed by regional variations in wages and prices, as well as the danger—now that cost indexes are "leveling off" in an upward direction—of rapid obsolescence.

A chapter is devoted to water distribution and sewer systems, but it suffers from cursory treatment and attention to outmoded technique—that is, to the use of bell-and-spigot pipe conforming to the AWWA's old 1908 specifications (rather than those of 1939 or 1952–53), and the use of braided hemp (not approved by the specifications for installation of cast-iron water mains).

An interesting appendix tabulates the estimated hourly cost of owning as well as operating many items of construction equipment, while in another table the cost of renting the equipment is given.

(Continued on page 46 P&R)

Check Are You Using a COAGULANT with These Advantages?

FERRI-FLOC brings you these superior features and more. It will coagulate waters and wastes over wide pH ranges as well as provide excellent flocculation in softening systems. FERRI-FLOC may be easily and safely handled in any type of standard equipment.

- ✓ ❶ Coagulation over wide PH ranges, color, turbidity and manganese removal.
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Coagulation of surface or well waters. Aids taste and odor control. Effective in lime soda-ash softening. Adaptable to treatment of nearly all industrial water or wastes.

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Coagulation over wide PH range. Efficient operation regardless of rapid variations of raw sewage. Effective for conditioning the sludge prior to vacuum filtration or drying on sand beds.

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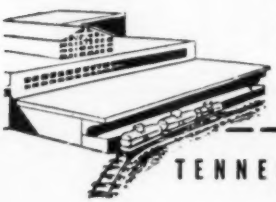

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SULPHUR-DIOXIDE is effectively used for dechlorination in water treatment and to remove objectionable odors remaining after purification.

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COPPER SULPHATE will control about 90% of the microorganisms normally encountered in water treatment plants more economically than any other chemical.

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The Reading Meter

(Continued from page 44 P&R)

River Purification. *F. T. K. Pentelow. Edward Arnold & Co., London (1953) 63 pp.; 5s ($1.25 from St. Martin's Press, 103 Park Ave., New York 17, N.Y.)*

The three Buckland Lectures for 1952 contained in this little book present a legal and scientific review of stream pollution and its control in the United Kingdom in the past century, with special emphasis on the peculiar interests of the fisheries. The author, who is chief inspector of salmon and fresh-water fisheries for the Ministry of Agriculture and Fisheries, concludes that pollution is at last being held to its present limits, and that the prospect for countering and at length eliminating it is excellent—"perhaps by the end of the next century."

Fire Prevention and Protection Fundamentals. *Gilbert E. Stecher, with Harry N. Lendall as consultant. The Spectator, Chestnut & 56th Sts., Philadelphia 39, Pa. (1953) 744 pp.; $10*

Whether it's called comburology, as the author would like, or plain old fire protection the subject is exhaustively treated, as it deserves to be. An entire chapter is devoted to water supplies for firefighting, but it is well to remember that the water utility stands in a double relationship to the threat of fire: not only does it help to meet it, but it can suffer from it as well, just as its customers do. Hence more will be found of interest in this book than may at first be apparent, and the book may be shared by those whose interests are normally far apart.

(Continued on page 48 P&R)

MUNICIPAL SUPPLIES
TRAFFIC SIGNALS
WATERWORKS
SEWERS
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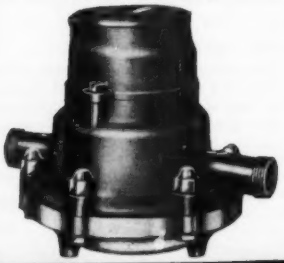
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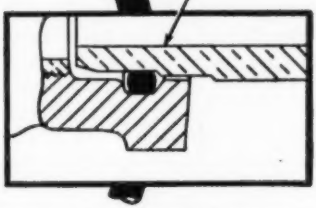
NEW RING-TITE JOINT.....



Smith A.W.W.A. Specifications Gate Valves (4" through 12") and Smith Fire Hydrants (with 4" and 6" connecting joints) are now available with Ring-Tite joints for direct connection to Johns-Manville Class 150 Transite Ring-Tite Pipe. No special fittings or extra joint material needed. Installation is quick, easy, economical, and joints can be made in any weather and in roughest terrain. Tight, flexible joints are assured. At low pressures, radial compression of rubber rings seals the joint; increasing pressure wedges the rings—the higher the pressure the tighter the seal. For complete details write for Bulletin RT 53.

44

FIRE HYDRANTS · VALVES · SINCE 1896

THE A.P. SMITH MFG. CO.

EAST ORANGE . NEW JERSEY

The Reading Meter

(Continued from page 46 P&R)

Sedimentation in Small Reservoirs on the San Rafael Swell, Utah. *M. J. King & M. M. Mace. Circular 256, Geological Survey, Washington 25, D.C. (1953) 21 pp.; paperbound; free*

The study reported by this booklet forms a link in a chain of contributions to the work of erosion control and sedimentation prevention, but the main emphasis here is on the quantitative determination of the rate of sedimentation and the way in which it varies. The group average for the area surveyed ranges between 0.3 and 2.6 acre-ft of sediment produced per square mile, depending upon the local geology.

Water Supply and the Texas Economy: *An appraisal of the Texas water problem. Senate Document No. 57, Eighty-third Congress, First Session. (1953) 91 pp.; paperbound; 25¢ from Government Printing Office, Washington 25, D.C.*

Prepared by the Area Planning Office of the Bureau of Reclamation at Austin, Tex., on the request of Senator Lyndon B. Johnson, this report summarizes the critical water supply problems of the Union's largest state. It is startling to learn that of 18 reservoirs on Texas Gulf Basin streams built or being built at a cost of $247,000,000 in federal funds, only one—Falcon Reservoir on the Rio Grande—is primarily intended for water supply, with 2.5 of 2.8 million acre-ft devoted to that purpose. The other 17 reservoirs allocate a total of only 1.2 million acre-ft to water supply, with 5.1 million to flood control and 2.4 million to hydro power. All these dams—and all of 13 additional dams still in the planning stage—were proposed before the full extent of the state's need for water was understood. The Bureau's chief recommendation is actually an organizational one—that the state set up a single agency to deal with its water supply problems.

Water Resources of the Milwaukee Area, Wisconsin. *William J. Drescher, Frederick C. Dreher, & Paul N. Brown. Circular 247, Geological Survey, Washington 25, D.C. (1953) 42 pp.; paperbound; free*

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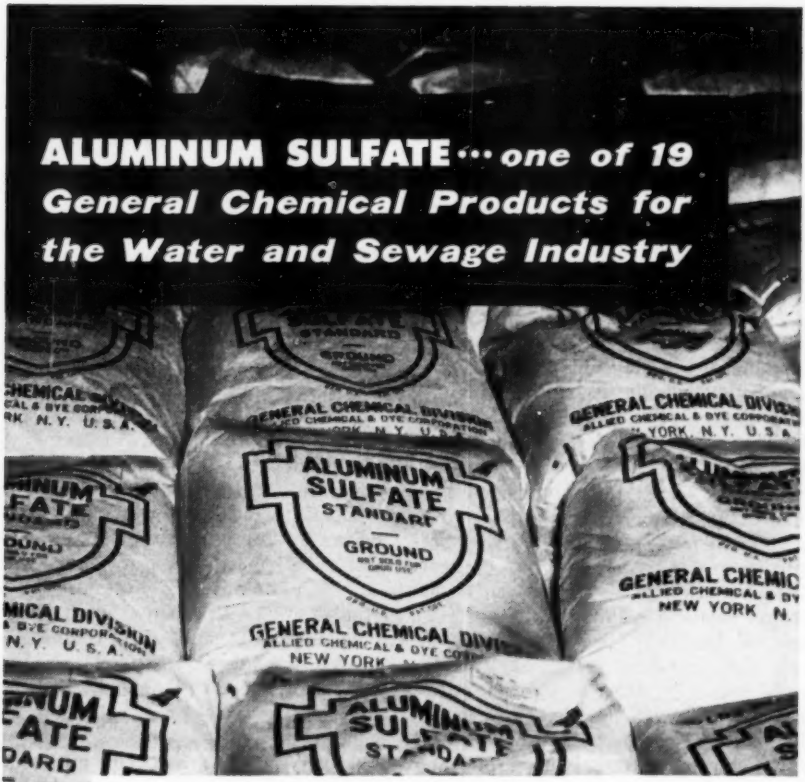
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Section Meetings

Ohio Section: The fifteenth annual conference of the Ohio Section opened on the evening of Sept. 9, 1953, at the Hotel Cleveland in Cleveland. Advanced registration that evening accounted for 75 of the 252 men. The total of 301 included 49 ladies—somewhat fewer than in previous years.

Chairman C. E. Beatty presided over the general session, opening the conference Thursday morning. Papers presented were: "Cross-Connection Control: Is It Worthwhile?" by E. S. Hoyt, assistant sanitary engineer, Ohio State Dept. of Health; "New ASA Specifications for Cast-Iron Pipe," by T. W. Wolfe, managing director, Cast Iron Pipe Research Assn.; "Development of Cleveland Water Improvement Program," by F. J. Schwemler, commissioner of water and heat, Cleveland; and "Basis of Design for Water System Improvements," by J. W. Avery, consultant, Havens and Emerson.

AWWA President M. B. Cunningham gave a short address on the Association, and F. J. Schwemler, local arrangements chairman, introduced Mayor Thomas A. Burke of Cleveland, who officially welcomed the water works men to the city.

Thursday afternoon separate distribution and purification sessions were held. Frank Ruck presided over the distribution session, at which the following papers were presented: "Installation and Maintenance of Valves and Hydrants," by F. H. Connors, city engineer, Van Wert; "Extending Water Service to Fringe Areas," by Pierce Bailey, general superintendent, Ohio Water Service Co.; "Use of Sulfur Compound Jointing Material," by Leo V. Garrity, assistant general manager, Detroit Dept. of Water Supply; "Relation of Water Quality Criteria to Municipal Water Supplies," by W. W. Towne, officer in charge, Ohio-Tennessee Drainage Basins, Public Health Service; "Fire Protection Requirements," by H. L. Krieger, assistant manager, Ohio Inspection Bureau.

D. E. Hazelswart was the presiding officer for the purification session as the following papers were presented: "Use of the Membrane Filter in Routine Water Analysis," by Elizabeth Collett, bacteriologist, Ohio Dept. of Health Laboratory; "Toledo's Plans for Stabilization of Water Supply," by R. R. Henderson, superintendent of purification, Toledo; "The Challenge of Taste and Odor Control," by K. W. Cosens, associate professor of civil engineering, Ohio State Univ.; a panel on "Problems in Cold Water Softening Plants," with Merrill L. Riehl, superintendent, Mahoning Valley San. Dist.; R. Shoup, superintendent, Van Wert; George Swanger, superintendent, Bowling Green; and J. H. Bass, Infilco, Columbus. "Standard Methods for Water Examination" was the subject discussed by W. D. Sheets, research engineer, Ohio State Univ.

The entertainment for the conference started with the cocktail hour sponsored by the Water & Sewage Works Manufacturers Assn., with Paul A. Harlamert of Cleveland presiding. The annual banquet was held in the ballroom with 254 attending. President M. B. Cunningham presented Life Memberships in AWWA to W. W. Morehouse, Dayton, and F. C. Tolles, Cleveland. A short business ses-

(*Continued on page 52 P&R*)

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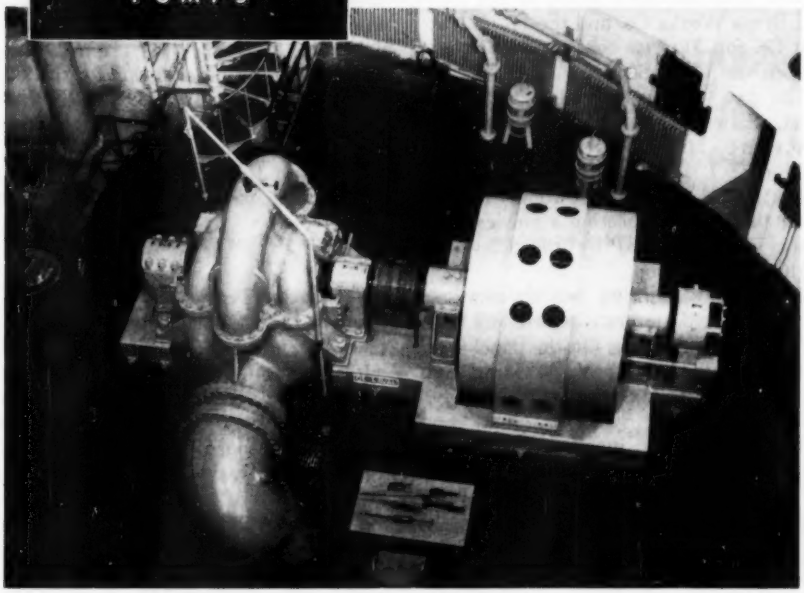

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Section Meetings

(Continued from page 50 P&R)

sion followed the banquet, at which time A. A. Ulrich of Massillon was nominated for the Fuller Award. The Wendell R. LaDue Citations were given to the Farnan Brass Works Co. and the H. C. Nutting Co. for 20 years continuous membership in the Ohio Section.

The new officers elected were: E. F. Leist, chairman; G. J. VanDorp, vice-chairman; M. E. Druley, secretary-treasurer; L. J. Hoffman, national director; and H. C. Growdon, trustee. After the business meeting a musical program was presented by the Cleveland Light Opera Group.

The Friday morning session consisted of a panel on water rate adjustment with E. F. Leist presiding. On the panel were W. R. LaDue, Akron; W. A. Gaige, Sylvania; R. B. Holt, Springfield; and G. J. VanDorp, Toledo.

The Friday noon luncheon was served at the new Nottingham Filtration Plant preceding an inspection trip through the plant. The tour was conducted by John Marsh, superintendent of filtration, and S. C. Simmermacher, chief mechanical engineer. Buses returned the group to the hotel.

A very enjoyable program for the ladies was planned by Mrs. F. J. Schwemler, chairman of the Ladies Arrangements Committee. The program included a luncheon and style show, as well as participation in parts of the main program.

Secretary-Treasurer
M. E. DRULEY

Kentucky-Tennessee Section: The twenty-fifth annual meeting of the Kentucky-Tennessee Section was held jointly with the seventh meeting of the Kentucky-Tennessee Industrial Wastes and Sewage Works Assn. at the Owensboro Hotel, Owensboro, Ky., on Sept. 21–23, 1953. Joint sessions were held on Mon-

(Continued on page 54 P&R)

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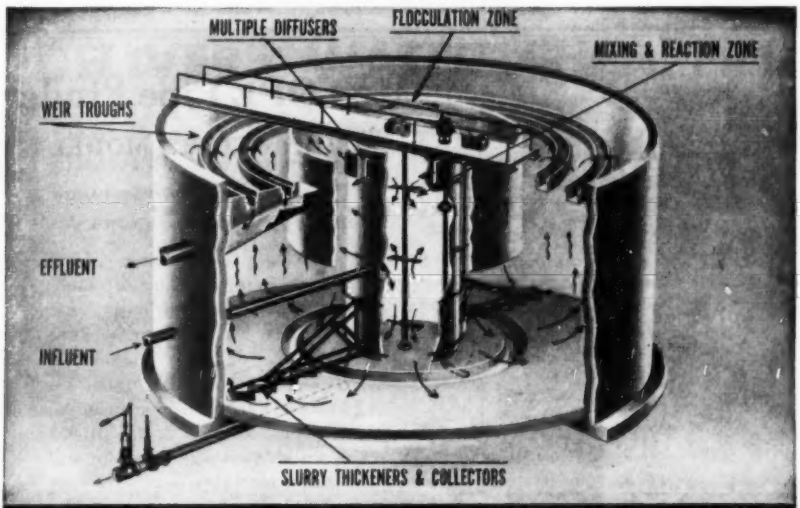

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Section Meetings

(Continued from page 52 P&R)

day and Wednesday, separate sessions on Tuesday. There were 161 men and 42 ladies registered for the meeting.

The joint opening session heard an address of welcome by Mayor LeRoy Woodward of Owensboro and a response by Justin J. Davis of Memphis, Tenn. "Sanity in Sanitation" was the subject of an address by President E. Sherman Chase of the Federation of Sewage and Industrial Wastes Associations; AWWA Secretary Harry E. Jordan discussed "Current Problems of the Water Works Industry."

During the afternoon, four technical papers were presented before the joint group. "Preliminary Findings on Pollution Conditions in the Ohio River from Cincinnati to Cairo" was presented by Robert K. Horton, staff engineer of the Ohio River Valley Water Sanitation Commission. Robert W. Wilson of Lexington, Ky., spoke on "Safety in Utility Plants." J. S. Lindsay, the adjutant general of Kentucky, discussed the need for adequate civil defense preparedness. The growth of the Owensboro, Ky., utilities systems was described by E. A. Farmer of the consulting firm of Black and Veatch.

On Monday evening the city of Owensboro was host at a cocktail party and barbecue dinner. The dinner was held at the utilities plant and the guests were given an opportunity to inspect the water plant and electric generating plant.

The separate session on Tuesday was opened by Homer E. Beckwith of the Pitometer Co., who discussed the economics of adequate leak surveys. "The Effect of Air Conditioning on Water Consumption and Distribution" was discussed by Robert L. Lawrence Jr., Nashville, Tenn.

A. E. Griffin discussed "Activated Silica as a Coagulant Aid," and "Taste

(Continued on page 56 P&R)

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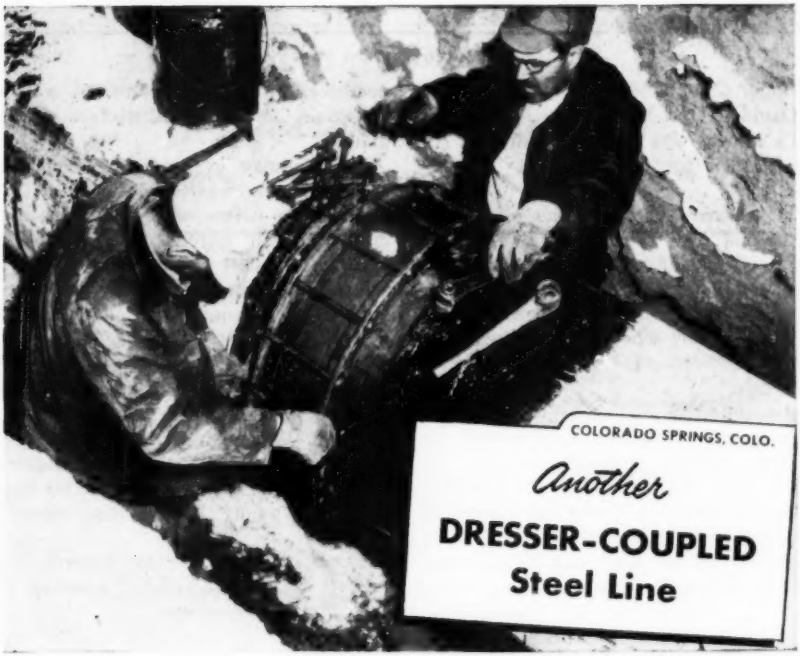

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Section Meetings

(Continued from page 54 P&R)

and Odor Control Methods" was the topic of David C. Colebaugh Jr. A. O. Putnam's subject was "Public Relations: An Opportunity for Your Water Department."

The afternoon session was opened by discussions on "What is New" in the region. Nick Johnson discussed the status of public water supplies in Kentucky, and J. Wiley Finney Jr. presented data on new water works constructed and major improvements to water works in Tennessee.

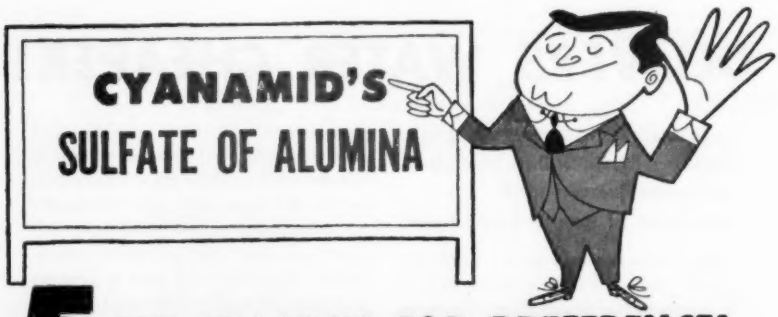
A round-table discussion with E. E. Jacobson as moderator highlighted the afternoon session. Subjects discussed included: the collection of sewerage charges by water departments, charges for water used by temporary users, at what interval meters should be read and billed, taste and odor problems, licensing water works operators, the use of various yarning materials, and the disinfection of new mains.

On Tuesday evening, a banquet and square dance was held in the Hotel Owensboro. New officers of both associations were introduced, and William Henry Lovejoy was announced as the selection for the Fuller Award.

Opening the joint session Wednesday morning, Robert L. Spencer discussed cathodic protection. "Engineering Reports and Rate Studies for Water and Sewer Systems" was discussed by J. Stephen Watkins, and P. M. Conway discussed the importance of the engineering report and rate studies from the financier's viewpoint. The meeting closed at noon.

J. Wiley Finney Jr.
Secretary-Treasurer

(Continued on page 78 P&R)



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Section Meetings

(*Continued from page 56 P&R*)

Missouri Section: The eighth annual meeting of the Missouri Section was held in Excelsior Springs, Sept. 27–29, 1953, jointly with the Missouri Water and Sewerage Conference. A total of 242 members and guests registered.

The morning sessions were designed to cover fields of common interest. The afternoon program was divided into three parts: two water divisions and one sewage division. One of the water division programs was designed chiefly for operators and the other for management.

Two films were featured: "Corrosion in Action" and "The River at Your Door," the latter depicting the results of stream pollution.

Citation certificates were presented to 23 members of the section for their services in the water works field and their membership in the Association. Robert H. McDonnell of Kansas City rated first in years of service and AWWA membership, with 55 years of continuous service in the water works field, 40 of them as an AWWA member.

AWWA Vice-President Dale Maffitt gave a constructive report of some AWWA policies. The Fuller Award Committee nominated H. O. Hartung of the St. Louis County Water Co. to be the recipient of the section's 1954 award.

WARREN A. KRAMER
Secretary-Treasurer

Iowa Section: The Iowa Section held its three-day annual meeting in Waterloo on Oct. 14–16, 1953. The total registration was 178, including 34 ladies and superintendents from 34 communities.

After a brief address of welcome by Mayor L. A. Touchae of Waterloo, the meeting got under way with a discussion on safety by Quentin Wildman of Fort Dodge and Harold Scendt of the Northwest Bell Telephone Co., Des Moines.

The afternoon was devoted to corrosion problems. M. K. Tenny of Des Moines explained how the outside of pipe could be protected, and M. E. Rew of

(*Continued on page 80 P&R*)

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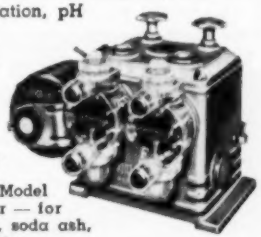

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Section Meetings

(Continued from page 78 P&R)

Council Bluffs discussed water treatment to prevent internal corrosion.

Thursday morning was devoted to public relations, and E. L. Filby of Kansas City read a very interesting and informative paper entitled "Let's Go Fishing" and S. C. Casteel of East St. Louis discussed labor relations.

Friday morning was devoted to small town water works problems, and a lively discussion of meters, distribution, maintenance, and purchasing ensued.

As a result of elections held during the business session, Warner J. Lang became the new chairman for 1954; Leo Louis the first vice-chairman; Tom W. Thorpe the second vice-chairman; and H. V. Pedersen, for the sixth time, secretary-treasurer. The report of the various committees indicates a healthy section.

H. V. Pedersen
Secretary-Treasurer

Wisconsin Section: The Wisconsin Section held its thirty-second annual meeting in Milwaukee at the Hotel Pfister on Sept. 22–24, 1953. The total registration was 288.

Preliminaries at the opening session Tuesday afternoon, presided over by Chairman Leistikow, included the official greeting from Walter M. Swielik, Milwaukee commissioner of public works. Bruno J. Hartman presided over the Surface Water Session the same afternoon, at which a paper on "Washing and Maintenance of Filters" was presented by John R. Baylis of Chicago. William U. Gallaher of Appleton discussed "Taste and Odor Experiences." The two speakers were then joined by Jerome Zufelt of Sheboygan, Hubert J. Evers of Merrill, and Gerald A. Rohlich of the Univ. of Wisconsin in a panel discussion of surface water supply problems.

(Continued on page 82 P&R)

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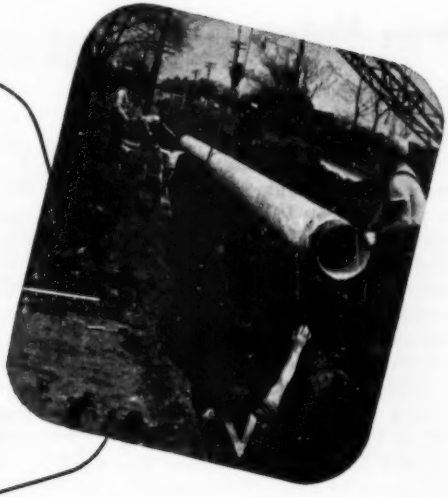

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Section Meetings

(Continued from page 80 P&R)

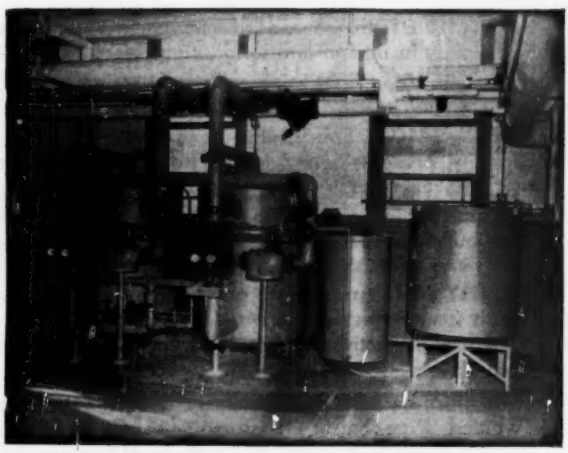
At the next morning's session, presided over by Verne Somers of Stevens Point, attention shifted to ground water. A "Summary of Ground Water Conditions in the Milwaukee-Waukesha Area" was presented by William J. Drescher of Madison. Lloyd L. Klinger of Wisconsin Rapids discussed "The Use of Polyphosphates for Well Cleaning and Iron Sequestration." Chairman Somers, H. F. Weckworth of Kaukauna, U. W. Baker of Wisconsin Rapids, and the two speakers conducted the panel discussion that followed.

At a luncheon Wednesday, AWWA President M. B. Cunningham discussed the projects on which the Association and its committees are currently busy. Harvey E. Wirth of Madison presided over the Distribution and Pumping Session which followed, and a film on "Metallizing—Its Practical Applications" began the session. William Hammann of Milwaukee reviewed hydrant installation, maintenance, and repair practices in approximately 75 Wisconsin communities. E. J. Duszynski of Cudahy began the discussion of the hydrant survey in the panel discussion that followed. O. J. Knechtges of Madison spoke on "The Economic Selection and Replacement of Pumping Equipment," and the topic was discussed by Arno T. Lenz of the Univ. of Wisconsin.

The banquet Wednesday evening was primarily social, limiting formalities to the introduction of the Association and section officers present.

At the General Session Thursday morning, with Edward F. Tanghe of Milwaukee in the chair, the section's Legislative Committee—A. E. Hintz, P. A. Reynolds, and A. P. Kuranz—reported favorable action on two bills in which the section was interested; unfavorable action on two others. Discussing "Office

(Continued on page 84 P&R)



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Section Meetings

(Continued from page 82 P&R)

Records for Tomorrow," J. A. Hammes of Sheboygan spoke on methods of customer accounting. At the panel discussion which followed, J. A. Hammes was joined by R. S. Butler and John D. Dahlk of the State Public Service Commission, P. A. Reynolds, and William Snell of Milwaukee.

An excellent ladies' program included a tour of the city, luncheon and a card party at the Elks Club, and attendance at the banquet.

LEON A. SMITH
Secretary-Treasurer

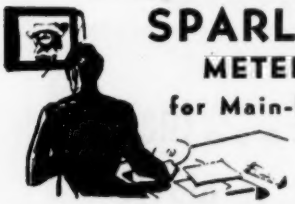
South Dakota Conference: The nineteenth annual meeting of the South Dakota Water and Sewage Works Conference was held in Rapid City, S.D., Sept. 22–24, 1953, with a registration of 121.

Wednesday morning, Sept. 23, was devoted to papers of interest to both water and sewage works operators. Mayor Wesser of Rapid City welcomed the group to his community and following the response by President Art Hanson, W. Jones of Allison-Williams Co., discussed water and sewage works financing with particular emphasis on legal procedures in South Dakota. This presentation was followed by a panel discussion on the voluntary certification of water and sewage works operators led by H. S. Smith, chairman of the Iowa Sewage Works Operators' Certification Committee.

The afternoon sessions of the first day were divided into sectional meetings, one for water works, the other for sewage.

On Thursday morning there were inspection trips of the Rapid City Water Works, the completely rebuilt Rapid City sewage treatment plant, and the new Rapid City Swimming Pool. An optional inspection trip was provided on Thursday afternoon, with a visit to the

(Continued on page 86 P&R)



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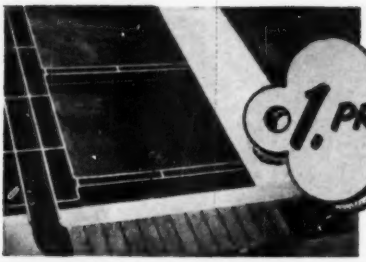

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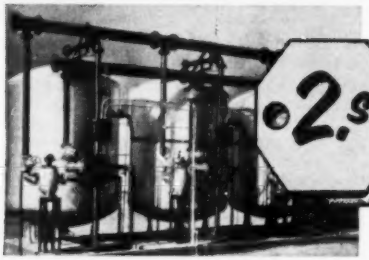

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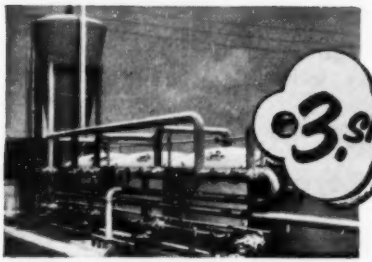

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(Continued from page 84 P&R)

Awards highlighted the South Dakota Conference as (left) Don Wessel of Mobridge received the $50 Flox Award from John Lynch, Flox service engineer, and (right) G. C. Redfield awarded the Izaak Walton League Plaque to B. A. Nangle, standing in for Clarence Shaul.

interior of the Black Hills at Hill City, and to the Lithium Corp. of America.

At the banquet on Wednesday evening, John Lynch, Service Engineer of the Flox Co., presented the annual $50 Flox Award to Don Wessel of Mobridge; G. C. Redfield of Rapid City presented the second annual Izaak Walton League Award to Clarence Shaul, Superintendent of Sewage Works at Hot Springs; and Plummer Wells, chairman of the newly established Longevity Award Committee, presented certificates to 16 water or sewage works operators in South Dakota who had served their communities in this capacity for 20 years or more. The banquet concluded with a very entertaining talk by H. S. Thorgrimsen, city manager of Rapid City.

The following officers were elected at the annual business meeting: president: Don Wessel; vice-president: Siger Bies: directors: G. J. Gunderson; Clarence Shaul; William Mailloux; Jacob Murschel; H. A. Fowler; and W. Campbell Jr.

CHARLES E. CARL
Secretary-Treasurer

"Power and Fluids" is the name of a new technical house organ to be published quarterly by Worthington Corp., Harrison, N.J. The first issue includes an article on troubles in direct-acting steam pumps which features a checklist of symptoms and their causes.

A case study of the use of punched-card business machines and the results a mechanized accounting system was able to bring to a small business office is the subject of a folder, CR 876, offered by Remington Rand Inc., 315—4th Ave., New York 10.

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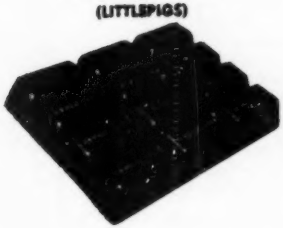

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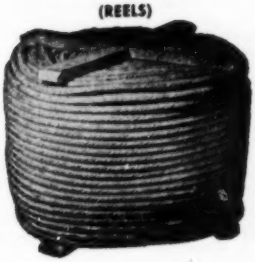

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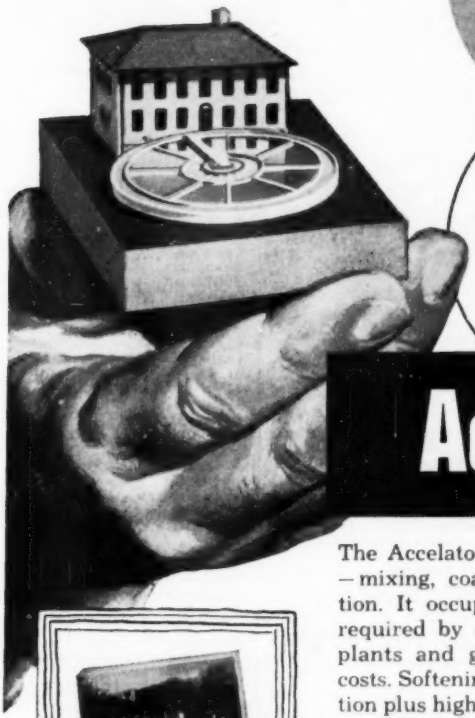

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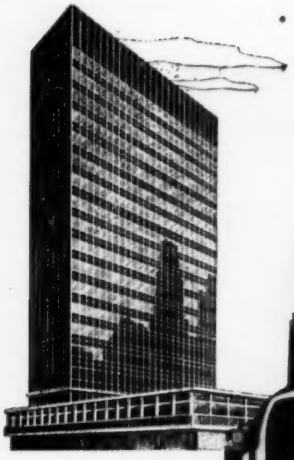

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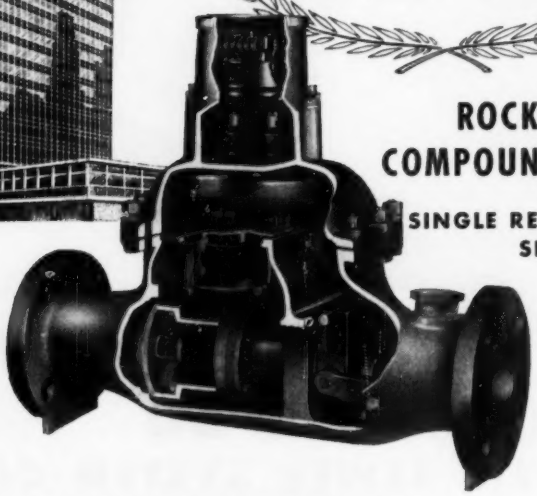

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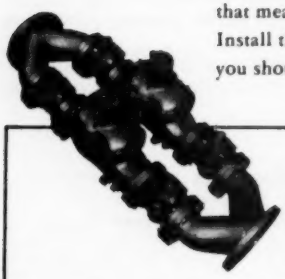

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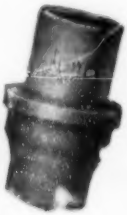
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